

FOREST RESEARCH
IN INDIA,

1937-38

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PART I.—THE FOREST RESEARCH INSTITUTE



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[This Report is printed on paper made in the Paper Pulp Section of the Forest Research Institute, Dehra Dun, from mixed species of bamboos.]

FOREST RESEARCH IN INDIA, 1937-38.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

The number of enquiries received continues to increase, more particularly in respect of utilisation subjects, interest in which has been greatly stimulated by the issue of a series of booklets and posters by the Timber Development branch.

Action was taken during the year to bring into effect the resolutions of the Utilisation Conference held in March 1937, and all the resolutions have received attention.

The Tariff Board visited the Institute twice during the year, once in connection with the utilisation of bagasse for fibre boards, and the other time in connection with the Paper Pulp protective duty enquiry.

During the year the Forest Research Institute, at the request of the Punjab Forest Department, co-operated in staging an attractive forest exhibit at the Industrial Exhibition held at Lahore during the cold weather 1937-38. A most attractive pavilion in the shape of a Himalayan temple was built by the Punjab Forest Department. The Forest Research Institute co-operated by supplying exhibits of panelling, parquet flooring, furniture, and numerous displays demonstrating the research work of the Institute.

Research, Dehra Dun.—An important event of the year was the visit to the Institute of the British and foreign delegates attending the Silver Jubilee session of the Indian Science Congress at Calcutta. A message, expressing the warm appreciation of all the delegates who had been at the Institute, was subsequently received from the President of the Congress.

Among numerous visitors to the Institute mention may be made of Mr. B. C. L. Jarvis of Messrs. Hitchin's Jarvis & Co., London, who came in connection with the Pomilio process of pulping raw materials, of Mr. Hof of Messrs. J. M. Voith & Co., to examine the working of the mechanical pulp grinder, of Mr. Maronne, General Manager the Mysore Paper Mills Co. Ltd., to study the

working of the fractional process of digestion for bamboos, and of Col. R. N. Chopra, I.M.S., Director of the School of Tropical Medicine and Hygiene.

To maintain closer contact between the Institute and the Provincial Forest Departments, and to enable officers better to keep in touch with what is going on in the world of forestry, a Research Demonstration course has been instituted. The first Course was held in October 1937 and was attended by some 15 officers, representing nearly all the Provinces. Judging by the opinions expressed by those attending, the Course was much appreciated. It is hoped to make the Course an annual one.

An important step taken to promote contact between the Forest Research Institute and Industry and in the development of the uses of wood, particularly of treated woods, has been the placing of the recently created Timber Development Section under the charge of a separate officer. This officer's chief functions are to advise on practical problems of utilisation and the dissemination in popular language of all available information on the uses of Indian timbers. Besides visits paid by him to the more important industrial centres where he was able to make contact with engineers and those engaged in the wood industries, he prepared and issued some 18 booklets which aroused a great deal of interest and led to many enquiries for designs and technical data.

Silvicultural Branch.—Work continued according to the triennial programme and good progress was made. The seed year was, in general, a rather poor one but early and regular rains resulted in a good growing season. Frost, as usual, though milder than in recent years, did a great deal of damage to young crops.

Routine work on seed testing and artificial regeneration trials was continued and a considerable amount of useful information obtained in respect of species which are of special interest to the provinces.

The main subjects under investigation are different methods of thinning, effects of root competition and early spacing, inheritance of racial characters in trees as a preliminary step towards selection and breeding of the varieties with the most valuable characteristics, studies in bamboo management, pruning, effects of controlled burning and comparative experiments in different methods of propagating the more important tree species.

One clear result which has come out of the All-India Teak Seed Origin plots at Dehra Dun is the great differences in frost hardness between teak from different parts of India and Burma.

Teak from Northern Burma is particularly frost hardy, whereas plants raised from seed from Travancore, Madras and South Bombay are most susceptible to frost damage, other origins being intermediate in their resistance to frost.

On the statistical side, field parties were sent to Coorg, the Andamans and the United Provinces for laying out statistical plots, collecting volume and heartwood data and laying out a number of sets of comparative thinning plots. Routine computation of sample plot files sent in by the provinces was continued, 487 plots being dealt with in the year. The compilation of data for an All-India Teak Plantation Yield Table was commenced, provisional curves for Nilambur being issued. A yield table for willow (*Salix alba*) in Kashmir was compiled.

The publication of notes on general subjects and of results of investigations has been held up owing to pressure of routine work, but two Indian Forest Records (Silviculture Series) came out during the year, one on "Seed weights, germination and plant per cents" for 505 different species grown in India, and the other on "The formation of heartwood and its amount in deodar timber".

In the museum, progress has been made on a model illustrating the working of forest under the "coppice with standards system", and a model showing the zonation of forest types with altitude in northern India was completed. A portable working model showing the effects of erosion when hill sides are denuded of forest cover was lent to the Lahore exhibition. A large number of lantern slides and photographs were lent to industrial exhibitions, educational institutions and others for illustrating popular or scientific lectures. A good collection was exhibited at the Jubilee Session of the Indian Science Congress at Calcutta. The photo section is, however, unable to keep up with all such demands owing to shortage of staff.

The record section has greatly extended in recent years, and in the year under report larger numbers of technical enquiries were replied to than ever before. This function of the Silviculturist as an information bureau is taking up an increasing amount of his time to the detriment of other work.

Botanical Branch.—A paper by Mr. Parkinson dealing with 5 species of the Dipterocarpaceæ was published during the year. It is hoped to publish shortly a further paper by the same author on the two Indian Dipterocarpaceæ, *Dipterocarpus indicus* and *Dipterocarpus bourdillonii* as also one on Indian Bambuseæ. Two papers

by Dr. Bor were submitted for publication during the year. One paper dealing with the known grasses of Assam, including several species new to science, the other on the synecology of the Ala Hills, Assam, a region about which our botanical knowledge is very meagre.

Large numbers of botanical specimens continue to be received for identification and while this work occupies a great deal of the time of the staff, they are none the less welcome and are very valuable in filling up lacunæ in the herbarium. More than 2,800 specimens were so incorporated in the herbarium during the year. Some 262 specimens were distributed to other herbaria as donations or exchanges. A number of specimens were also loaned out to specialists engaged on the study of various plant groups. Numerous requests for authentic samples of seed were received during the year and several hundred packets of seeds were so supplied to the Provincial Forest Departments and to various botanical institutions within India and in other countries with whom exchange relations are maintained.

Linear Increment plots, laid out in Madras and Coorg in the evergreen forests with the object of studying the structure and content of these forests and also the life of the individual species, were visited by the Forest Botanist during the past cold weather and some 7,000 trees were identified or specimens taken for study.

The investigations on shisham (*Dalbergia sissoo*) root disease and seven species of *Peridermium* occurring on Indian conifers have been completed and papers on them are being prepared for publication.

The fungal diseases which cause widespread unsoundness and mortality of sal trees (*Shorea robusta*) in Bengal, Bihar and United Provinces are at present engaging the attention of the Mycologist. A number of such fungi were collected and identified during his tour in the Bihar and North Bengal sal forests. The factors which predispose the trees to infection by these fungi are being studied with the object of discovering some protective means. A histological study of sal mycorrhiza is now being undertaken.

A preliminary test of the toxicity of Ascu and of cicorate has been carried out and further experiments on these preservatives are being continued.

Entomological Branch—The most important part of the year's work was again the study of the parasites of defoliators of teak, sissoo and mulberry. An insectary has been maintained at Nilambur to study the defoliation of teak and the parasites of the

defoliators. An interesting feature of this work has been the successful transference of parasites from Burma to the teak plantations at Nilambur, the parasites being shipped in cold storage to Madras and thence by parcel rail in Nilambur. Lists of desirable and undesirable plants as factors in the control of *puera* and *maehaeralis* have been compiled and will shortly be published as the result of ecological surveys carried out in these teak plantations. A project to distribute and colonise the parasites of sissoo defoliators in the Punjab sissoo plantations will be undertaken in the coming year. Colonies of parasite—*Cedria paradora*, reared at Dehra Dun on the mulberry defoliator—*Margaronia pyloalis*, were transported to the Changa Manga plantations, some 15,700 parasites being released in June and 20,600 in November. The fauna of lantana was studied at Dehra Dun throughout the year, some 50 species of the insect pests of this weed being investigated. It is estimated that over 400 species of insects visit lantana. It has been established that the lantana seedfly, introduced to Bangalore it is believed in 1921, and which has since spread over the whole country—is of no importance in preventing the germination of fallen lantana berries.

Although no field work was undertaken by the Forest Research Institute, large collections of sandal insects were identified for the Madras Forest Department. Studies in the seasonal incidence and distribution of the Heteroptera of sandal were completed with the examination of the remaining 1,600 specimens, which added 25 species to the insect fauna of sandal.

The Entomologist completed a very thorough study of the bostrychid wood borers which are pests of sawmills and factories.

The staff of the Systematic Section was busily engaged in the arranging, identifying and summarizing data on large numbers of insects sent in by forest officers, collected on tour and reared in the insectary. Specialists in other countries continue to give their assistance. 351 Indian species were added during the year to the reference collection. Descriptions of 44 new species of *Crossotarsus*, Platypodidae, were published as an Indian Forest Record.

Utilisation Branch.—The year was a very busy one for the Utilisation Branch. The number of enquiries shows an increasing interest in utilisation subjects. The booklets issued by the Timber Development branch stimulated interest in timber structures generally and treated woods particularly and a great deal of the time of the Utilisation Officer was spent in supplying information on these subjects. During January 1938, the Utilisation Officer

undertook an extensive tour visiting Bombay, Madras, the West Coast, Ootacamund, Cuttack, Tatanagar and Calcutta.

In the Timber Testing Station, some 30,000 tests and nearly as many experiments were carried out during the year. 9 new species of timber were tested to determine their strength properties and poles of 4 species were tested for their suitability for electric transmission, telegraph and telephone lines. The increased interest now being taken in civil aviation in this country resulted in the submission of an unusually large number of glue joints for testing in this section.

The number of kilns in operation and under construction in this country continues to increase in response to the demand for seasoned wood. A large number of enquiries in this connection was dealt with by the Seasoning Section, designs and plans for the installation of these kilns being drawn up and supplied to the enquiring firms. Efforts are being directed to improve on the present design of the tunne kiln with a view both to simplify its construction and operation and also to avoid the slight superficial discoloration of the dried wood which results from the hot combustion gases coming directly into contact with the wood. Equipment for an improved design of this type of kiln, which will admit of indirect heating, has been worked out and is now an order.

There is a very definite demand for a simple and cheap type of kiln and one of the aims of this Section is to design such a kiln—preferably one requiring no steam or motive power, which will cost not more than Rs. 1,000 to construct.

Attention continues to be given to the seasoning of railway sleepers. An investigation into the air seasoning of chin (*Pinus longifolia*) sleepers has been started in the East Almora division of the United Provinces. A small experiment in the seasoning of M. G. sal (*Shorea robusta*) sleepers a year before use was also started in co-operation with the Rohilkhand and Kumaon Railway.

Another important investigation started during the year in this section has been the seasoning for a manufacturing trial of Indian woods for hand and power loom shuttles. A number of indigenous woods have been tried in the past for these purposes but have been found unsuitable, mainly on account of defective seasoning. Blocks of kiln dried samples of *Anogeissus latifolia* have already been sent out for trial, and similar blocks of other species will be sent out as soon as the necessary supplies are received and have been kiln dried. Amongst other investigations in hand in this Section

may be mentioned that of finding indigenous woods suitable for use as battery separators, all of which are at present imported from America.

In the Paper Pulp Section, amongst the more important experiments carried out in the experimental factory were those on the production of kraft paper from *Dendrocalamus strictus* and of printing and writing papers from *Saccharum munja* (mung grass) and *Cymbopogon coloratus* (botha grass). With the installation of the wood pulp grinder, investigations were started into the production of mechanical pulp from *Broussonetia papyrifera* (Paper mulberry), chir (*Pinus longifolia*) and spruce (*Picea morinda*). The first results were not very satisfactory, the pulp being short in fibre and of a brownish colour. A number of adjustments to the plant are being made and the experiments will be continued. The preparation of a cheap printing paper using a mixture of bamboo chemical pulp with mechanical pulp of various softwoods will be tried out. In the laboratory a number of grasses were tested for their suitability for paper making. A large scale test on one of these grasses—*Anthusiu gigantea* (ulla grass)—has been arranged to be carried out at the Lucknow Paper Mills. A series of experiments was carried out on the production of kraft paper from *Pinus longifolia* and *Dendrocalamus longispatus*. The tear and burst factors in the case of both these species compared favourably with those of imported kraft paper. The investigation into the causes of discolouration of pulps has been held in abeyance pending the appointment of a chemist. The experiments on the production of insulation and wall boards from bagasse—undertaken on behalf of the Imperial Council of Agricultural Research—were commenced towards the close of the year. The services of Mr. Bhargava, the Officer in charge of the Section, were again in much request by paper mill owners and by those contemplating erection of new paper mills.

The Wood Technologist continued his work on the preparation of hand lens keys with low power photomicrographs for the identification of the more important commercial timbers of Bengal and Assam. Some 81 specimens were received from these Provinces. Studies on the formation of growth rings in some 12 important species were continued. Of other investigations undertaken by him may be mentioned, the anatomical study of the gurjans and allied timbers, the best method of tapping *Sterculia urens* for its gum (*karar*), the effect of resin tapping on the chir tree, and the relationship between the anatomical structure and the physical properties of teak (*Tectona grandis*). In addition some 320

identifications of woods were carried out on behalf of various Government Departments, public bodies, the trade and others.

In the Wood Preservation Section, service tests were started on fence posts and poles treated with Aseu and creosote for comparing their relative preservative values. An investigation was also started to see if the Madison method of treating green sapling posts by means of motor tyre tubes could be used with advantage on Indian woods. If successful this process would save much wastage which occurs in the forest and during transit by the attack of boring insects and of fungi. An open tank treatment with Aseu for posts and sapwood billets was tried and proved successful. Various proprietary wood preservatives and treated fibre boards were received for testing against termites and other destructive agents. The study of the movement of preservatives in wood, with special reference to Aseu and creosote, was started during the year under review. The investigation of the causes of the erratic permeability of chir (*Pinus longifolia*) to preservatives is in progress. A further series of experiments on the mechanism of the fixation of Aseu in wood has been taken in hand. The work in this connection and the effect of soil salts on the leaching of Aseu is being continued.

Owing to the Assistant Minor Forest Products Officer, being required to assist the Utilisation Officer as personal assistant, the activities of the Minor Forest Products Section were largely confined to the answering of enquiries, the up-keep of the minor forest products garden and the maintenance of records. Of the more important enquiries in this section may be mentioned those in connection with the F. R. I. charcoal kiln of which there are now 25 in operation, charcoal briquetting and the cultivation of medicinal and insecticidal plants.

In the Wood Workshop and Veneer Sections chief attention was again paid to the work in plywoods and veneers, the interest in which, on the part of the trade is shown by the very large number of enquiries received in this connection. The working qualities of a further 10 species of indigenous timbers were investigated and 3 further species were peeled for tests under Project VIII.

Chemical Branch.—During the year under report *Viter peduncularis*, which is a reputed remedy for blackwater fever, has been investigated and an active constituent has been isolated which is being examined pharmacologically.

The study of the Indian fish poison plants has led to the discovery that Iotenone, the toxic constituent of *Deris*, is present in

Millettia pachycarpa and *Tephrosia candida*. *Millettia* and *Tephrosias* occur in abundance in some of our forests and the fact that wild plants have yielded rotenone is a matter of considerable importance and economic value, since it might be possible to improve the toxic constituents with cultivation.

The work on oils and fats has indicated that *Actinodaphne augustifolia* and *Litsea citrata* are further sources of Lauric Acid which in recent years has become so valuable.

Timber Development Branch.—The first activity of the new Timber Development Branch was the compilation of a number of popular propaganda booklets which were printed and released during the year. More than 26,000 copies were distributed free to the general public, business firms, Government Departments, etc. They created a great deal of interest and led to a large number of enquiries regarding timber structures and treated woods. In conjunction with the Timber Testing Section, designs and specifications were drawn up for a number of timber structures, such as wooden bridges for spans from 50 to 70 feet, roof trusses 20 to 60 feet spans, portable huts and watch towers. The Timber Development Officer himself undertook an extensive tour, visiting the larger industrial centres and interviewed a number of business firms, engineers and others interested in the use of timber.

CHAPTER II.—SILVICULTURE BRANCH.

I.—Experimental Silviculture.

(i) NATURAL REGENERATION.

The study of annual seed production and fertility of individual *Anogeissus latifolia* trees (Expt. No. 44) was continued for the 10th year. It was not a good seed year and two out of four sample trees did not produce seed. Germination per cent. for the seed collected ranged from 28 to 59.

Seed crops from individual trees of *Shorea robusta*, *Tectona grandis*, *Pinus longifolia* and *Terminalia tomentosa* were also observed and recorded. Except *Shorea robusta* it was not a good seed year for others. None of the *T. tomentosa* trees under observation produced any seed.

(ii) INVESTIGATIONS ON SEEDS.

(a) *Seed weighments and germination tests*.—During the year under report 102 weighments were made including 5 new species, and germination tests for 102 species were carried out. Indian Forest Records, Silviculture Series, Vol. II, No. 5, published in 1937, incorporated most of the data collected in previous years.

(b) *Seed storage*.—The following results of germination tests with seed stored for different periods in (i) sealed tins and (ii) gunny bags were obtained. The statement includes species under trial since 1932.

Species.	Date of collection.	Date of first fl. t.	GERMINATIVE CAPACITY.									
			STORING IN TINNS FOR			STORING IN CUSNEY BAGS FOR						
			1 year.	2 years.	3 years.	1 year.	2 years.	3 years.	4 years.	5 years.	Per cent.	Per cent.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
<i>Acorus americanus</i>	June 1906.	July 1906.	34	3	—	40	Nil	—	—	—	—	—
<i>Acorus americanus</i>	June 1906.	July 1906.	17	3	—	—	—	—	—	—	—	—
<i>Acorus americanus</i>	February 1911.	April 1911.	79	11	—	—	—	—	—	—	—	—
<i>Acorus americanus</i>	May 1911.	June 1911.	72	15	9	22	4	7	—	—	—	—
<i>Acorus americanus</i>	June 1911.	June 1911.	76	22	—	35	—	—	—	—	—	—
<i>Barbarea orthoceras</i>	April 1912.	May 1912.	22	37	1	0	Nil	—	—	—	—	—
<i>Barbarea orthoceras</i>	May 1912.	August 1912.	29	14	12	9	Nil	—	—	—	—	—
<i>Barbarea orthoceras</i>	March 1913.	April 1913.	1	—	—	4	10	8	—	—	—	—
<i>Cedrus libani</i>	May 1913.	June 1913.	31	Nil	—	Nil	—	—	—	—	—	—
<i>Cedrus libani</i>	March 1913.	April 1913.	31	Nil	—	Nil	—	—	—	—	—	—
<i>Cedrus libani</i>	September 1913.	October 1913.	48	17	—	23	1	—	—	—	—	—
<i>Cedrus libani</i>	May 1913.	June 1913.	15	15	—	Nil	—	—	—	—	—	—
<i>Dioscorea torricensis</i>	May 1913.	June 1913.	15	15	10	16	5	—	—	—	—	—
<i>Dioscorea torricensis</i>	May 1913.	June 1913.	15	15	10	16	5	—	—	—	—	—
<i>Eleocharis acicularis</i>	April 1913.	May 1913.	37	15	68	52	2	Nil	—	—	—	—
<i>Eleocharis acicularis</i>	February 1913.	March 1913.	65	71	34	66	—	—	—	—	—	—
<i>Eleocharis acicularis</i>	June 1913.	July 1913.	47	—	—	7	Nil	—	—	—	—	—
<i>Eleocharis acicularis</i>	May 1913.	June 1913.	47	—	—	7	Nil	—	—	—	—	—
<i>Eleocharis acicularis</i>	August 1912.	September 1912.	13	13	—	15	4	Nil	—	—	—	—
<i>Eleocharis acicularis</i>	January 1913.	February 1913.	75	70	—	15	4	Nil	—	—	—	—
<i>Eleocharis acicularis</i>	May 1913.	June 1913.	67	11	—	10	7	Nil	—	—	—	—
<i>Eleocharis acicularis</i>	February 1913.	March 1913.	Nil	63	—	13	07	—	—	—	—	—

* Per 1000 seeds; (—) discontinued; (..) continued.

Similar storage tests have been commenced during the year for *Chlorophora excelsa*, *Ougenia dalbergoides*, *Olea glandulifera*, *Pterocarpus dalbergoides*.

(iii) INVESTIGATION ON SEEDLINGS.

The morphological seedling studies were discontinued as they were no longer considered necessary.

(iv) INVESTIGATIONS ON TREES AND CROPS.

(a) *Seasonal course of height growth*.—The investigation was continued for 14 common Indian species, weekly or periodical measurements being taken throughout the year. Observation was also commenced on *Araucaria cunninghamii*.

(b) *Phenological data*.—Observations were recorded on 14 common species in collaboration with the provinces, and a note will shortly be issued on the subject.

(c) *Inheritance of individual characters*.—The *Terminalia crenulata* plots of reputed figured and unfigured origins, and *Pinus longifolia* plots raised for determining the hereditary character of high resin yielding capacity, were maintained with necessary tending operations.

(d) *Inheritance of climatic racial characters*.—The experiment under the All-India teak seed origin dealing with 11 origins was discontinued after recording morphological differences between the plants of different origins. Biometric measurements of leaves of different origins were recorded, analysed and significant differences determined on a comparison of their mean figures. Besides, leaf descriptions of six origins were prepared on the basis of their obvious differences in size, colour, texture, etc., and a key for their determination was compiled by the Botanist. Reported differences in appearance between Burma and local origins of *Acacia catechu* persisted throughout the year.

(e) *Inheritance of physiological race characters*.—The small plantations of different forms of *Butea frondosa* and *Schleichera trijuga* were more or less frosted again this year. They were maintained and morphological differences only studied.

(f) *Soil quality class indicators*.—The ecological quadrats in plantations of the Demonstration Area were maintained and mapping was done as usual.

(g) *Congestion in bamboo clumps*.—The prescribed treatments of different methods of cutting round the periphery, topping and

stripping, etc., were applied to selected clumps of *Dendrocalamus strictus*.

(h) *Root competition*.—The experiments reported on last year were continued on the following species:—

Shorea robusta.—(a) Analysis of this year's figures again indicated a significant increase in diameter growth in the plots where root competition was eliminated as compared with the control plots.

(b) The 6' apart line sowings of sal done in 1933 and sown thinly and thickly in alternate lines at right angles to the east to west edge of a crop of big sal poles, to study the effect of competition between seedlings themselves are still under observation. Alternate pairs of lines have been trenched annually to a depth of 18" cutting through all roots from adjoining wood.

Results for (a) and (b) are being analysed.

Pinus longifolia.—Same as *Shorea robusta* (a) above.

Cedrela toona.—The experiment as reported last year was kept under observation. The root competition from the surrounding growth was eliminated by trenching all round one of the plants in each of the comparable pairs (growing under the same conditions) and isolating them by galvanised iron.

Phorbe lanceolata.—As *Cedrela toona* above.

Holoptelia integrifolia.—Same as *Cedrela toona* and *Phorbe lanceolata* above except that this has been trenched in sets of three plants.

Results.—No significant differences in growth were observed in the case of last 3 species.

(i) *Thinnings in young plantations*.—The five sets of experiments in replicated series in the younger *Pinus longifolia* plantations in the Demonstration area were maintained. As reported last year, the factors under investigation are (i) comparison of different grades and methods of thinnings (C-grade, D-grade and "free thinnings"), (ii) to compare the effects of different dates of first thinning, (iii) to compare the effects of different early espacement on growth and form, (iv) comparison of thinnings to different fixed numbers of stems per acre, and (v) comparison of different thinning cycles. It is too early to report any results so far.

(j) *Pruning versus natural cleanings*.—The two investigations in *Shorea robusta* and *Pinus longifolia* crops into the effects of

pruning versus natural cleaning on growth and timber quality were continued.

(k) *Twist in Pinus longifolia*.—The experiments of (a) attempting to induce twist and (b) studying the heredity of twist in *Pinus longifolia* were continued. Plants raised from X-rayed seed are progressing and will be examined for occurrence of twist as soon as they are large enough for the purpose.

(l) *Controlled burning*.—The experiment on determining the effects of early burning in young *Pinus longifolia* plantations was continued.

(v) ARTIFICIAL REGENERATION.

As reported last year the 1936 monsoon had arrived much earlier than usual, in the beginning of June, and continued up to the end of September. There were copious winter rains also in December. Frost occurred, as usual after the winter rains, but was not as severe as in the previous few years. The year was a damp one.

The 1937 monsoon also broke a little earlier than usual,—in the second week of June, and rains were regular up to the 3rd week of September. As in 1936, the plants had a longer rainy season than during previous years. There were a good many lasting showers in the middle and towards the end of winter. These were followed by frost which, though not very severe, was fairly so, and affected some plantations in the experimental garden and demonstration area.

(a) *Line sowings*.—The following species were tried in the open as well as in shade during 1937:—

Bombax malabaricum, *Boswellia serrata*, *Celtis tetrandia*, *Cordia myxa*, *Erythrina suberosa*, *Lagerstræmia parviflora*, *Ougenia dalbergioides*, *Terminalia myriocarpa*, *Xylia dolabriiformis*. Of these *Boswellia serrata* and *Terminalia myriocarpa* failed, the others did well. Plants were more or less affected by frost particularly those of *X. dolabriiformis*.

(b) *Rains entire planting in the open*.—The following species were tried in 1937. The survival per cent. at the end of the year is given in brackets. The plants have not yet been through a hot weather:—*Cassia fistula* (40), *Cedrela toona* (78), *Hovenia dulcis* (87), *Morus alba* (99), *Pterocarpus dalbergioides* (86), *Xylia dolabriiformis* (73).

For the species planted in 1936 the following are the survival percentages at the end of the first and second growing seasons respectively.

Cedrela toona (74-46), *Holoptelia integrifolia* (78-38), *Lagerstræmia parviflora* (55-50), *Morus alba* (82-6*), *Machilus gamblei* (96-6*), *Swietenia macrophylla* (96-10*) and *Terminalia citrina* (96-58). Casualties were mainly during the hot weather. (Figures marked* were at the end of the first hot weather, when these particular experiments were closed).

(c) *Rains entire planting in cleared lines under shade.*—The following species were planted in 1937, the survival per cent. at the end of the year being given in brackets:—

Cassia fistula (82), *Cedrela toona* (53), *Hovenia dulcis* (96), *Morus alba* (99), *Pterocarpus dalbergioides* (96), *Xylia dolabriformis* (98).

As regards the species tried in 1936, the following are the survival per cent. at the end of the first and second growing seasons respectively:—

Cedrela toona (69-48), *Holoptelia integrifolia* (59-38), *Lagerstræmia parviflora* (11-closed), *Lophopetalum fimbriatum* (99-53), *Morus alba* (82-66), *Machilus gamblei* (98-58), *Swietenia macrophylla* (62-2*) and *Terminalia citrina* (92-44). Casualties were mainly during the hot weather (* vide note above).

(d) *Winter entire planting in the open and under shade.*—Of the three species planted out during February 1937, two, viz., *Machilus gamblei* and *Morus alba* survived. *Anthocephalus cadamba* died during the hot weather of that year.

The following species were put out during February 1938:—

Eugenia jambolana, *Ougeinia dalbergioides*, *Schinus wallichii* and *Stereospermum suaveolens*.

(e) *Winter stump planting in open and cleared lines.*—At the end of the first growing season, the survival percentages for *Acacia modesta*, *Hovenia dulcis*, *Latsea polyantha*, *Mallotus philippinensis*, *Pongamia glabra*, *Swietenia macrophylla*, and *Terminalia paniculata* tried in 1937 were 30, 44, 50, 42, 55, 43 respectively in the open.

The following species were planted during 1937-38 cold weather:—

Acacia modesta, *Alcurites fordii*, *Bauhinia purpurea*, *Holoptelia integrifolia* and *Terminalia chebula*.

(f) *Rains stump planting in the open*.—The species put out in 1936 are mentioned below with their survival percentages (within brackets) at the end of the first and second seasons respectively:—

Cassia siamca (100-52), *Cedrela australis* (100-92), *Cordia myxa* (100-100), *Hovenia dulcis* (44-25), *Lagerstræmia parviflora* (98-90), *Prosopis spicigera* (99-87), *Pterospermum acerifolium* (100-91), *Terminalia paniculata* (98-84). These were all healthy at the close of the year.

With the species tried in 1937 the following results were obtained at the end of the year, the figures in brackets giving the survival per cent.:—

Acacia modesta (83), *Cassia siamca* (59), *Holoptelia integrifolia* (100), *Phæbe hainciana* (90).

(g) *Rains stump planting under shade*.—The species put out in 1936 showed the following survival percentages at the end of the first and second seasons respectively:—

Cordia myxa (98-98), *Eugenia grandis* (65-10), *Eugenia operculata* (99-20), *Hovenia dulcis* (70-47), *Lagerstræmia parviflora* (96-88), *Pterospermum acerifolium* (98-90), *Terminalia paniculata* (88-50), *Terminalia tomentosa* (88-68). Of these only *Eugenia grandis* almost died out in the second year of drought and frost.

The following species were tried in 1937, their survival per cent. at the end of the season being given in brackets:—

Acacia modesta (88), *Cassia siamca* (22), *Diospyros tomentosa* (88), *Holoptelia integrifolia* (96), *Phæbe hainciana* (98), *Svietenia macrophylla* (46), *Terminalia citrina* (65).

(h) *Storage of stumps before planting*.—The 1936 experiments with *Cedrela toona* and *Terminalia tomentosa* stored in moist sack-ing under thatch shelter for 0, 4, 7, 10 and 13 days showed the following results at the end of the second growing season:—

Cedrela toona.—The survival percentages were 56, 58, 60, 78 and 58 with corresponding average heights of 27·2", 27·4", 31·1", 29·2" and 30·1".

Terminalia tomentosa.—The survival percentages were 48, 46, 42, 42 and 44 with corresponding average heights of 19·5", 26·0", 24·0", 26·2" and 24·3".

In 1937, *Dalbergia vissoo* and *Terminalia tomentosa* were tried under similar conditions.

Dalbergia sissoo.—250 stumps of different diameters prepared on the 10th June 1937 were planted out in comparable sets of 50 stumps after storage up to 13 days in moist sacking under thatch shelter. Rains continued during the planting periods and also afterwards. At the end of the growing season the survival percentages were 98, 100, 100, 96 and 100 with corresponding average heights of 13.1", 12.5", 12.8", 12.6" and 13.3" for stumps stored for 0, 4, 7, 10 and 13 days respectively.

Terminalia tomentosa.—The number of stumps and the initial treatment were the same as for *Cedrela toona*, but the date of preparing the stumps was the 13th June 1937. At the end of the year the survival percentages were 98, 100, 100, 100 and 100 with corresponding average heights of 22.7", 20.9", 22.8", 20.8", 20.4" for stumps stored for 0, 4, 7, 10 and 13 days respectively. Rains were continuous up to the end of the month.

(i) *Early planting of stumps without irrigation*.—The fortnightly planting of 25 *Bombax malabaricum* stumps was started from the 5th January 1937, in the open and was continued up to the 23rd June 1937. The survival percentages at the end of the year were 100, 96, 96, 100, 96, 92, 100, 92, 88, 92, 96, 88 and 80 with corresponding average heights of 13.8", 13.8", 14.3", 14.3", 13.1", 11.0", 14.2", 11.7", 12.8", 11.8", 10.7", 12.1" and 13.9" for 1 to 13 sets respectively. Occasional showers of rain during the planting periods were helpful and the results are fairly uniform without shewing any very marked superiority of any particular date for stump-planting *Bombax malabaricum*.

(j) *Comparison of nursery stock and natural seedlings*.—Nursery and forest plants of *Cedrela toona* were tried this year and at the end of the first growing season the survival percentages were 88 for nursery and 84 for forest plants with corresponding average heights of 4.6" and 3.3" respectively. This again confirms previous year's results with *Eugenia jambolana* that, if transplanted, forest plants suffer by comparison with plants raised in the nursery.

(k) *Comparison of nursery and forest stumps*.—*Bauhinia variegata* and *Eugenia jambolana* planted in 1936 showed at the end of the 2nd year survival percentages of 94 and 80 for nursery stumps, and 68 and 76 for forest stumps respectively; their average heights being 40.4" and 13.1" for *Bauhinia* stumps and 24.5" and 13.0" for *Eugenia*.

(l) *Delayed date of planting stumps*.—During the rains of 1936 trials were made with *Acacia catechu* and *Cedrela toona*,—stumps

having been prepared on the respective dates of planting. The planting commenced on 13th June 1936 and was continued at weekly intervals until 11th July 1936, i.e., 5 sets of 25 stumps each time, stumps being graded into 0.1" diameter classes. The following statement gives their survival percentages (numerators) with corresponding average heights (denominators) at the end of the first and second seasons:—

Species.	SURVIVAL PER CENT. WITH CORRESPONDING AVERAGE HEIGHTS.									
	Set 1 of 13-6-36.		Set 2 of 20-6-36.		Set 3 of 27-6-36.		Set 4 of 4-7-36.		Set 5 of 11-7-36.	
	1st year.	2nd year.	1st year.	2nd year.	1st year.	2nd year.	1st year.	2nd year.	1st year.	2nd year.
<i>Acacia catechu</i>	$\frac{88}{18.4''}$	$\frac{84}{59.9''}$	$\frac{96}{16.1''}$	$\frac{88}{56.5''}$	$\frac{36}{13.1''}$	$\frac{32}{57.1''}$	$\frac{Nil}{0}$	$\frac{Nil}{0}$	$\frac{72}{13.6''}$	$\frac{68}{55.1''}$
<i>Cedrela toona</i>	$\frac{100}{15.2''}$	$\frac{92}{36.7''}$	$\frac{100}{15.4''}$	$\frac{92}{34.7''}$	$\frac{68}{12.1''}$	$\frac{60}{28.5''}$	$\frac{25}{7.4''}$	$\frac{16}{25.3''}$	$\frac{76}{8.1''}$	$\frac{44}{30.2''}$

In the above experiment the rains commenced from 21st June with premonsoon showers on 13th, 15th and 17th.

In 1937 the experiment was repeated with *Dalbergia sissoo*. The operations were the same as in 1936. The planting commenced on 10th June 1937 and was repeated weekly until the 5th set was planted on 6th August 1937. Survival percentages at the end of the first season were 100, 100, 100, 100 and 100 with their corresponding average heights, as 17.7", 16.2", 15.9", 15.0" and 10.1" for each set respectively. The rains commenced from June 20th with premonsoon showers on 9th to 11th and on 14th.

(m) *Comparison of sowing, transplanting and stumping.*—In continuation of last year's statement, results for the species under trial since 1935 to date are mentioned below including the survival percentages of the older plants with their corresponding average

heights at the end of 1937. Each operation was done at the season which, as far as known, was the most favourable for it:—

Year of planting or sowing.	Species.	Method (sowing or planting).	SURVIVAL PER CENT, AT THE END OF THE YEAR.			Average height at the end of 1937. (inches).
			1935	1936	1937	
1935	<i>Acacia catechu</i> . .	Direct sowing . . .	83	75	50	58.1
		Entire transplanting . .	63	45	25	49.3
		Stump planting . . .	78	65	30	60.8
	<i>Bombax malabaricum</i> .	Direct sowing . . .	70	..	..	..
		Entire transplanting . .	93	50	88	18.3
		Stump planting . . .	90	90	88	32.1
1936	<i>Acacia catechu</i> . .	Direct sowing . . .	..	95	65	50.5
		Entire transplanting . .	..	70	48	32.8
		Stump planting . . .	..	88	52	53.5
	<i>Bombax malabaricum</i> .	Direct sowing . . .	..	100	88	12.4
		Entire transplanting . .	..	95	40	19.8
		Stump planting . . .	..	98	95	18.8
	<i>Cedrela toona</i> . .	Direct sowing . . .	..	80	13	23.2
		Entire transplanting . .	..	05	8	22.7
		Stump planting . . .	..	100	99	44.0
	<i>Celtis tetrandia</i> . .	Direct sowing . . .	..	30	..	..
		Entire transplanting . .	..	88	30	33.3
		Stump planting . . .	..	100	80	38.3
1937	<i>Dalbergia sissoo</i> . .	Direct sowing . . .	..	..	63	4.8
		Entire transplanting . .	..	..	65	8.5
		Stump planting . . .	..	..	95	17.9
	<i>Morus alba</i> . . .	Direct sowing . . .	..	..	35	6.6
		Entire transplanting . .	..	..	93	15.9
		Stump planting . . .	..	..	99	11.3
	<i>Pterospermum acerifolium</i> .	Direct sowing . . .	..	..	95	4.5
		Entire transplanting . .	..	..	88	4.2
		Stump planting . . .	..	..	100	3.7

(n) *Branch cuttings*.—In the rains of 1936 *Morus alba* branch cuttings were planted in crow-bar holes. These cuttings were 12" long and their diameters ranged between 0.3"-0.6". Their survival percentages were 74 and 46 at the end of the first and second growing seasons with corresponding average heights of 13.9" and 53.3" respectively. The experiment was repeated in 1937 with *Morus alba*, but this time the cuttings were graded into diameter

and length classes, and 50 such branch cuttings of each set were planted. Results at the end of the first season were as follows:—

Set No.	Diameters of cuttings.	Length of cuttings.	Survival per cent.	Average heights.
I	0.3" — 0.6"	9"	28	13.1"
II	0.4" — 0.8"	12"	36	12.2"
III	0.5" — 0.8"	18"	40	15.9"
IV	0.6" — 1.1"	24"	28	19.4"

(o) *Propagation from lateral root systems.*—In August 1935, 50 lateral roots of *Dalbergia sissoo*, arranged in 0.1" diameter classes, ranging from 0.2" to 1.1" in diameter, were planted out in pits, flush with the ground level. Results at the end of first, second and third growing seasons were as follows:—

Season.	Survival per cent.	Average heights.
1st season	80	3.8"
2nd season	66	23.1"
3rd season	66	47.9"

(p) *Number of plants per patch.*—Plants of *Pinus longifolia* raised by patch sowing were later on thinned out leaving 1, 2, 3 and 4 seedlings per patch in a replicated series. The following table gives their progressive annual results to the end of 1937:—

Year.	No. of plants per patch.			
	1	2	3	4
	Average heights in inches.			
1933	9.0	9.7	9.7	9.7
1934	14.2	16.6	16.8	16.8
1935	22.6	23.1	24.3	24.3
1936	37.3	35.0	39.3	39.2
1937	65.3	66.5	69.0	67.2

It would appear that differences in height growth were not significant.

The experiment was repeated with *Acacia catechu* sown in 1935 and thinned to the required number of plants per patch in 1936, and *Bombax malabaricum* sown in 1936 regularised in 1937, and with *Terminalia tomentosa* in 1937 with 2, 3, 4 and 5 plants per patch. Their results are tabulated below:—

Species.	Year.	No. of plants per patch.				
		1	2	3	4	5
		Average heights in inches.				
<i>Acacia catechu</i> . .	1936 . .	29·0	29·1	29·0	29·0	..
	1937 . .	55·4	62·4	63·2	56·4	..
<i>Bombax malabaricum</i> .	1937 . .	9·1	9·0	9·1	9·0	..
<i>Terminalia tomentosa</i> .	1937 . .	..	8·1	8·1	8·4	8·3

(q) *Araucaria plantations*.—The *A. cunninghamii* plantation of 1931 is growing well and has reached a maximum height of 14' at the end of the 6th year.

Plants of *Araucaria bidwillii* mixed with *Pinus longifolia* in 1929 have attained a maximum height of 13' at the end of 8 years. The small plot planted up with *A. bidwillii* during 1936 was maintained with necessary tending operations and the plants look quite healthy and promising with a maximum height of 30" at the end of the last season.

(vi) NURSERY WORK.

The seed crop in the forests of the Dun valley was not good during the year. Flowers, seeds and fruits of many species were blown away by one of the heavy storms that occurred in the valley during the month of June and wrought considerable damage. Stock of various species was raised for use in the Experimental garden and Demonstration area.

The following experiments were carried out in the nursery during the year:—

(a) *Experiments with different degrees of nursery bed shades* (Experimental 14) were repeated with *Adina cordifolia* and *Anthocephalus cadamba*.

Adina cordifolia.—Results were the same as in previous years in that stocking and development were the best under tin shade, fairly good under thatch, poor under batten and worst in the open.

Anthocephalus cadamba.—Germination, stocking and development were the best under batten shade, good under thatch and fairly good under tin and poor and patchy in the open—thus practically confirming last year's results except that results under tin shade were better than under thatch last year.

(b) *The manuring experiment (No. 16) in nursery beds* having the same past history was continued with the seeds of *Morus alba*. *Crotalaria juncea*, *Cassia tora* and *Lucerne* were again used this year as green manure in 3 different beds, whereas artificially prepared farmyard manure was added to two other beds separately at the rate of 10 and 20 baskets per bed as last year; besides three other beds were prepared with 10 and 20 baskets of farmyard manure and *Adco* respectively. One separate bed was kept as control. *Morus alba* was the species used for test and the quantity of seed used for the nursery beds was the same in all cases. The average heights of *Morus* plants for each kind of manure are given below:—

Manure.	Average heights in inches.	Remarks.
1. <i>Crotalaria juncea</i>	10·7	Results show considerable variation year after year.
2. <i>Cassia tora</i>	12·1	
3. <i>Lucerne</i>	11·2	
4. Artificial farmyard, 10 baskets	8·6	
5. Ditto 20 „	10·0	
6. Farmyard manure, 10 „	11·3	
7. Ditto 20 „	9·5	
8. <i>Adco</i> — 10 baskets	10 4	
9. Control	10 0	

Cassia tora seems to have given the best results this year. 10 baskets of farmyard manure and all green manures proved decidedly better than the control.

(c) *Best material for seed covering* (Experiment No. 92).—An experiment was conducted to determine the efficacy of various seed covers, viz., (a) well washed coarse sand, (b) sifted decomposed vegetable manure (made using “*Adco*”), (c) farmyard manure and (d) sifted nursery soil, on the rapidity and uniformity of

germination of shaded and unshaded *Kydia calycina* and *Terminalia chebula* seeds.

The data collected were analysed according to the technique of analysis of variance, with the result that the different covers had no significant effect on the maximum germination of the two species whether shaded or unshaded. A significant result however was obtained on the rate and germination in case of unshaded beds, the coverings in order of efficacy being (b), (c), (d) and (a), with no marked difference between (b) and (c).

(d) *Best time for seed collection*.—5 lots of the seed of *Terminalia chebula* collected on 7th December 1936, 15th December 1936, 23rd December 1936, 2nd January 1937 and 11th January 1937 were sown in randomised beds on the same day and under similar conditions. At the end of the year, the survival percentages of plants from seed of different dates of collection were 16, 8, 10, 4 and 4 respectively, with their corresponding heights as 4.4", 4.3", 5.3", 5.1" and 4.6".

(vii) MISCELLANEOUS.

A small plantation of *Agathis palmerstonii* has been raised in the Experimental garden. The two small plantations,—one of *Broussonetia papyrifera* raised from branch and stem cuttings and the other of *Hovenia dulcis*, raised by stump-planting last year, were tended. About 42 per cent. of the former have sprouted so far and a few more are likely to follow next rains when casualties will have to be replaced as required. The plants of *H. dulcis* are making good progress with a maximum height of 6 ft. and an average height of 3½ ft., while the survival per cent. is 92.

(viii) RECLAMATION AND AFFORESTATION.

(a) *Miscellaneous Working Circle*.—*Acacia catechu*, *Bambusa polymorpha*, *Cedrela toona*, *Dendrocalamus strictus*, *Dendrocalamus longispathis* and *Morus alba* raised for afforesting the failed teak compartments as mentioned in last year's report were tended during the year. Blanks in existing teak and *Gmelina* compartments were planted up with stumps and entire transplants of miscellaneous species. Thinnings were also done in some of these compartments, combined with pruning in the *Gmelina* crop.

The rosewood plantation in two adjoining compartments has been regularly pruned and the miscellaneous species, chiefly the quick-growing *Broussonetia papyrifera*, removed wherever interfering with the rosewood.

Plants of *Alcurites fordii* and *A. montana* are now fairly established in one of the cleared rosewood compartments. A small plantation of *Celtis tetrandia* was also raised during the year under report. As stipulated last year a 15-acre plot has been sown with *Pinus longifolia* to raise crops for an extensive replicated set of thinning experiments. Five more compartments leased out to *taungya* cultivators will be used up next rains.

(b) *Sal Working Circle*.—Compartments 1, 2, 10 and 11 were thinned. Blanks in some of the compartments were planted up with the stumps of *Cedrela toona*. *Tephrosia vogelii* was sown in C. 12 in connection with Experiment No. 41 (cover crop). Frost occurred this year as usual but damage was limited to small and unprotected plants only. Mixed line sowings of *Dalbergia sissoo*, *Dodonaea viscosa*, and *Bauhinia* species, carried out last year were found to have afforded some protection to tender sal against light frost.

(c) *Chir (Pinus longifolia) Working Circle*.—The chir crops of various origins were kept under observation and all experiments herein were maintained.

II.—Statistical Section.

(i) YIELD TABLES.

The total number of existing sample plots (including tree increment plots) to the end of the year was 1,723 against 1,656 of the previous year. 487 plot files were computed during the year while 476 sample plot files (including those for 57 new plots) were received from different provinces for routine computations.

During the year under report the Central Silviculturist with a field party laid out 39 new sample plots in Coorg. A few more were laid out by the Statistical Assistant Silviculturist in the Andamans towards the close of the year.

Yield tables were compiled for the plantation willow (*Salix*) from data received from Kashmir. Provincial yield table curves relating to the main crop of Nilambur plantation (Madras) were prepared in connection with revision of the working plan. Enough data were collected and worked out for an all-India teak plantation yield table to be published in the near future.

(ii) MISCELLANEOUS.

Single tree volume data were computed for *Terminalia tomentosa* for some provinces on the basis of such figures as could be accepted.

III.—Miscellaneous.

(i) PUBLICATIONS.

Two Indian Forest Records of Silviculture Series were published during the year, one on "Seed weights, plant per cents., etc., for forest plants in India" (in revision of Forest Bulletin No. 41), and the other on "The formation of heartwood and its amount in deodar timber", besides a number of contributions from the Branch published in the *Indian Forester*.

A monograph on the silviculture and regeneration of the *Dipterocarpus* spp. is ready for the press, and revision of Forest Bulletin No. 78 on the problem of the pure teak plantation and an All-India teak plantation yield table were partly completed.

(ii) PHOTOGRAPHIC SECTION.

Heavy arrears of work which had accumulated in the past have been considerably reduced. The demand for photos and slides, etc., has been steadily on the increase from different provinces, for their industrial exhibitions, educational institutions and others for illustrating popular or scientific lectures. A good collection was also exhibited at the last Jubilee session of the Indian Science Congress at Calcutta.

The total number of prints in the general series comes to 4,561 and in the specific 5,146, against 3,798 and 4,529 respectively for the last year, thus adding a total of 1,380 photographs in the collection during this year against 457 of the previous year.

2,635 prints were prepared for different Provinces, States and educational institutions, and 50 were made for reproduction in various publications. Collection of 16 m.m. films has also been just commenced.

(iii) RECORDS.

The documentation part, increasing from year to year, has always been an important routine work of the Branch. Although large numbers of publications (including periodicals) were marked for ledger files during the year under report, there is yet much scope for improvement. In the matter of ledger filing the Branch, with its present limited staff, cannot make proper use of the vast amount of literature received each year. In many cases it can do little beyond referencing them in a general way.

New ledger files opened during the year were 30 under the specific and 16 under general, their totals at the end of the year

being 1,307 and 486 respectively. 67 new books and working plans were added to the library during the year, bringing the total to 786 with 573 bound volumes of periodicals.

Abstracting of all Indian forest literature was continued as usual for the five agencies in India and abroad, and lists of additions of important books with their brief abstracts were circulated to all the provinces.

(iv) WORKING PLANS.

Notes were written on two plans under preparation during the year,—one for the Cachar division (Assam) and the other for Hoshangabad (Central Provinces).

(v) MUSEUM.

The model illustrating the altitudinal zonation of forest types was completed as well as another new model for the "coppee-with-standards" system. Besides, necessary improvements were made to the older models and enlarged photographs were partly coloured. Fifty selected stereo-photos on a stand were also added to the museum. A portable duplicate erosion model was also completed which was lent to the Lahore exhibition where it attracted considerable notice.

(vi) TOURS.

Mr. M. V. Laurie toured in Kumaon in the hot weather in connection with the resin tapping experiments and in the cold weather in Coorg and in Madras. In Coorg he laid out a number of statistical plots.

Mr. M. A. Kakazai, Statistical Assistant Silviculturist, reverted to the United Provinces and was succeeded, on the 17th April 1937, by Bakshi Sant Ram of the Punjab Forest Service who remained thereafter in charge of the Statistical Section throughout the year. He toured in Chakrata (United Provinces) in connection with the remeasurement of sample plots. He was also deputed to the Statistical Laboratory, Presidency College, Calcutta, for a period of 2½ months for a short course under Prof. Mahalanobis. Mr. Sant Ram also represented the Forest Research Institute at the Statistical Conference held at Calcutta under the auspices of the Science Congress, where a paper on "Some practical aspects of the application of statistical theory to silvicultural research" by the Central Silviculturist (Mr. Laurie) was read. He toured with a field party in the Andamans in connection with the sample plot work from February 1937.

CHAPTER III.—BOTANY BRANCH.

Systematic Botany.

A brief reference was made in last year's report to a paper on two South Indian Dipterocarps, *D. indicus* and *D. bourdillonii*, and another on Indian *bambuseæ*. These papers have not yet been completed, but Mr. C. E. Parkinson is still working on them and it is hoped to publish them during the next year.

A paper dealing with five species of the *Dipterocarpaceæ* was published by Mr. Parkinson during the year.

A paper dealing with the known grasses of Assam, including several species new to science, was also completed and submitted for publication.

Synecology.—A paper on the synecology of the Aka Hills, Assam, a region about which our botanical knowledge is very meagre, was submitted for publication.

Identification of specimens.—1,406 specimens from outside sources were identified during the year, this number includes part of a large collection from the Nilgiris made by the Forest Botanist.

Mention has been made in previous reports of the large number of specimens which are received and identified as a matter of routine and it has been stressed that such identification takes up a large portion of the time of the Forest Botanist and his assistant. This is true but at the same time collections sent in by forest officers from all over India are very welcome; they very often are exceedingly valuable in helping to fill up lacunæ in the herbarium. Material from Madras is greatly desired for although some of the best botanists in the Indian Forest Service worked in the Madras Presidency, this herbarium contains surprisingly few sheets of their collections.

One hundred and seventeen specimens were sent to the Royal Botanic Gardens, Kew, and twenty-two to the Royal Botanic Garden, Calcutta, for identification or for confirmation.

Herbarium.—2,837 specimens were incorporated during the year. The more notable totals include Dr. N. J. Bor's 1,179 sheets (Naga Hills, England, Ceylon and Hongkong), M. B. Raizada's 432 sheets (Dehra Dun and Jaunsar), Botanical Forest Officer, Assam's 257 sheets, C. E. Parkinson's 110 sheets (Kunaon, Bashahr, Burma), Director, Melbourne Botanic Garden's 129

sheets, Gray Herbarium's 99 sheets. Dr. Bor's Naga Hill collection was specially welcome as it contained very many species which were not represented in the herbarium. The remainder was made up from the numerous smaller collections and individual specimens sent in by forest officers and others.

The following specimens were distributed in exchange or donations:—

The Principal Botanist, Department of Agriculture, Pretoria, South Africa	70
The Director, New York Botanical Garden, New York, N. Y., U. S. A.	70
The Forest Botanist, Maymyo, Burma	117
The Botanical Forest Officer, Shillong, Assam	5
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Total	262
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Dr. R. R. Stewart, Professor of Botany in the Gordon College, Rawalpindi, worked in the herbarium on ferns for a week.

Rao Bahadur T. S. Venkatraman, Government Sugarcane Expert, Imperial Sugarcane Station, Lawley Road Post, Coimbatore, consulted the collection of grasses.

Professor S. A. Akhtar of Kabul worked for sometime in the herbarium on his Afghanistan specimens.

Library.—Forty-six books and fifty-seven volumes of periodicals were added to the library during the year.

Tours.—Mr. C. E. Parkinson undertook a three weeks' tour in the Simla Hill States during the month of June in order to find the "aromatic sage" of Fraser, which is believed to be the "soma" plant of Hindu mythology. He travelled over Fraser's route and came to the conclusion that the "aromatic sage" could be no other plant but *Meriandra strobilifera*.

The Forest Botanist toured in Madras and Coorg for six weeks in November-December in order to identify the trees standing on the linear increment plots laid out by the Silviculturist, Madras. About 7,000 trees were dealt with.

Mr. Mukat Behari Raizada visited the Agri-Horticultural Garden, New Delhi, in July to select plants for the Botanical Garden.

Dr. K. D. Bagchee toured in the Chakrata forests in May, June and July in connection with his investigation into Himalayan coniferous rusts. He toured in Bengal and Bihar in January and February in connection with the diseases of the sal tree.

Seed supply.—The demand for small authentic samples of seed continues to increase year by year. The list of seeds offered in exchange from the Arboretum and Botanical Garden of the Forest Research Institute was as usual distributed to all provincial forest departments in India and to various botanical institutions in India and abroad with which seed exchange relations are maintained. About 500 packets of seeds were supplied in response to the numerous requests received.

In addition to the above, 31 indents aggregating about 1,150 pounds of seed were supplied during the year. The seeds supplied include a number of exotic species requisitioned by the Central Silviculturist and other forest officers from the provinces. The following seeds were obtained and supplied to them:—

1. *Tephrosia vogelii*, *Pinus caribaea*, *Markhamia platycalyx* and *Chlorophora excelsa* to the Central Silviculturist.
- 2 European larch (*Larix europaea*), Japanese larch (*Larix kaempferi*) and Korean larch (*Larix dahurica* var. *Principis Ruprechtii*) for the Divisional Forest Officer, Garhwal Forest division, United Provinces.
3. *Hamatoxylon campechianum* for the Forest Research Officer, Bihar.

The seeds mostly in demand were:—*Acacia senegal*, *Actinodaphne hookeri*, *Sagera elliptica*, *Cupressus torulosa*, *Chlorophora excelsa*, *Tectona grandis* from Malabar, *Hydnocarpus wightiana*, *Taraktogenos kurzii*, *Eucalyptus naudiniana*, *Cassia auriculata*, *Gmelina arborea*, *Azadirachta indica*, *Pinus excelsa*, *Albizia pinetorum*, *A. roxburghiana*, *Bombax malabaricum*, *Samocarpus anacardium*, *Sapium schiferum*, *Dalbergia sissoo*, *Pinus longifolia*, *Cedrus deodara*, *Acacia arabica*, *Avicennia pendula*, *Prosopis glandulosa* and *P. juliflora*.

Botanical Garden and Arboretum.—During the period under review work in the Botanical Garden continued to make steady progress and the results so far obtained justify the money and labour spent on its maintenance. About 80 plants representing 20 families and 33 genera were planted out during the year. The "Glass House" in which various cacti and succulents are displayed is an attractive and interesting addition to the garden. The rearrangement of the Rose Garden has been a success. The winter and rainy season show of annuals adds greatly to the attractiveness of the garden which is now being visited by an increasingly large number of visitors. The growth of creepers on the Green

House is progressing favourably and as soon as the whole is covered it is proposed to grow shade-loving plants inside it.

In the experimental garden and nursery about 300 plants were raised for planting in the Arboretum and Botanical Garden; in addition to this number about 400 were distributed for planting in residential grounds at New Forest, the adjoining Indian Military Academy and elsewhere in Dehra Dun.

Planting in the Arboretum continued to make good progress, about 90 plants having been planted out during the year. For the improvement of the grounds a plot of land west of Trevor road was fenced in and planted up with ornamental species known to do well locally.

Miscellaneous.—As usual many enquiries on botanical subjects received from forest officers and others in India were answered and advice given in botanical matters.

Mycology.

Shisham root disease.—A paper incorporating the results of this investigation is now ready for publication.

Sal root disease.—The Mycologist undertook an extensive tour in Bihar and Bengal where the disease is most prevalent. As a result of his field studies *Polyporus shoreæ* appears to be the common cause of root-rot of sal in both provinces.

Trametes incerta which seems to induce a heart-rot of the stems of poorer class sal is apparently restricted to Bihar (Conversion and Hill Working Circles) only.

Of the fungi which cause sap and outer heart-rot *Fomes tricolor* and *F. melanoporus* occur in both provinces but *F. lamaensis* appears to be confined to Bengal.

Pne cultures of these fungi have been established and cultural studies commenced.

A collection of various types of fungi on sal was made during the tour and identified at Calcutta.

The United Provinces sal forests (Gorakpur, Bahraich, Pilibhit, Haldwani, Ramnagar and South Kheri divisions) where sal suffers from various kinds of unsoundness have not been visited as yet, but it is proposed to do so shortly in order to make a comparative study of these diseases.

Mycorrhizal fungi and associated problems.—An histological examination of sal mycorrhiza has been made and microscopic drawings prepared. Cultural work is in progress,

It is now proposed to grow sal seedlings in sterile (a) water, (b) soil and (c) *Agar Agar* in order to determine the most suitable media for their growth and for the purpose of inoculations with pure cultures.

The investigations into "damping off" of forest seedlings and the "die-back" of *Gmelina arborea* have had to be omitted from the programme of work for want of time.

Cultural studies of some fungi attacking coniferous trees and their pathogenicity.—Seedlings of *Pinus excelsa* and *Cedrus deodara* which were inoculated at Chakrata several years ago with pure cultures of *Trametes pini* and *Fomes annosus* respectively have been definitely infected and have produced the characteristic rot. Isolations from them developed the same organisms again.

The biological relations of the following coniferous rusts have been established with their alternate forms by inoculations and a paper on each is under preparation:—

Cronartium himalayense (= *Peridermium himalayense*)—The third paper dealing with the successful inoculations on pine (*Pinus longifolia*) with the teleutostage from *Swertia* is being prepared. The inoculations from pine to *Swertia* have already been recorded in a previous paper.

Cronartium ribicola (= *Peridermium indecun*).—The inoculations from *Pinus excelsa* (*P. indecun*) to *Ribes rubrum* and from *R. rubrum* (*Cronartium ribicola*) to *P. excelsa* have been successfully carried out and the genetic connection between the two rusts determined.

Similarly, *Peridermium orientale* (= *P. complanatum*) on the needles of *Pinus longifolia* has been matched with *Coleosporium campanula* on *Campanula calcarata*; *Peridermium brevius* on needles of *Pinus excelsa*, with *Coleosporium* n. sp. on *Senecio rufinervis*; *Peridermium piceæ* on *Picea morinda* with *Chrysomyxa himalayensis* on *Rhododendron arboreum*; *Peridermium ephedræ* on *Ephedra vulgaris* with *Hyalopora* n. sp. on *Athyrium acrosticoides* and *Peridermium abies-pindriana* on *Abies pindrow* with *Uredinopsis* n. sp. on *Polypodium* sp.

The undermentioned Himalayan rusts still remain unmatched:—

Peridermium cedri on *Cedrus deodara*, *P. thomsoni* on *Abies pindrow*, *Chrysomyxa piceæ* on *Picea morinda*, *Chrysomyxa dietelii* on *Rhododendron lepidotum*, *Peridermium*

near cerebrum on stem of *Pinus khasya* and *Peridermium* sp. on needles of *Pinus khasya*.

Toxicity tests of wood preservatives.—The preliminary experiments having been completed it is now proposed to use cultures of *Polystictus hirsutus* and *Schizophyllum commune* to test the toxicity of *Ascu* as compared to that of Creosote + fuel oil preservative.

Routine problem.—The inoculation of *Dalbergia latifolia*. No further work was done.

Herbarium.—A large collection of fungi has been made, identified and added to the herbarium.

Museum.—A number of important wood-lots of conifers and broad-leaved hardwoods are being added.

Pure cultures of *Trametes incerta* on sal, *Merulius similis* on *Dendrocalamus strictus* and a dry rot fungus on walnut have been added this year.

CHAPTER IV.—ENTOMOLOGICAL BRANCH.

CEDRELA TOONA INSECTS.

The parasitism of *Hypsipyla robusta* was studied by sack-banding toon trees in the New Forest Estate; 18,800 larvæ were collected, the maximum from one tree being 386. The parasites of larvæ of the first and second generations included Braconidæ 4 species, Chalcidæ 3 species, Ichneumonidæ 3 species, Tachinidæ 1 species; the predators were *Opilo discodirus* and *Idgia melanurus*. Ichneumonids parasitised the shoot boring larvæ of the winter generation.

DALBERGIA SISSOO INSECTS.

The shisham plantations Changa Manga, Chichawatni, Daphar, Khanewal, Miranpur and Shahdara were visited in May to study the extent of parasitism of *Plecoptera reflexa* and other defoliators and to obtain material for breeding in the Dehra Dun insectary. Several hundred thousand caterpillars were despatched from all localities by the Forest Entomologist and by the divisional staff. Unexpected difficulties in transport were encountered and excessive mortality occurred owing to high temperatures and rough handling on the railways; it will be necessary to devise special methods for packing and protection of live insect consignments if transport on a large scale is to succeed. A project to distribute and colonise the parasites of shisham defoliators in the plantations will be undertaken next year.

Exorista picta, a tachined parasite of *Plecoptera reflexa*, was studied at Dehra Dun and was carried through 6 generations up to March 1938; parasitism of third and fourth stage larvæ up to 20 per cent. was obtained.

Trichogramma minutum from eggs of *Hyblaea puera* was reared on eggs of flour moths. Rearings on incubated *Plecoptera reflexa* were started in December and 5 generations in eggs of the last species were carried through.

LANTANA INSECTS.

In connection with the problem of controlling lantana by means of its insect pests the fauna of this weed was studied at Dehra Dun throughout the year. Over 50 species were investigated of which 36 species attack the leaves, 10 the soft shoots, 7 the flower buds, 32 the flowers, 13 the young fruits, 10 the mature

fruits and one species bores the woody stems. It is estimated that over 400 species of Indian insects visit lantana.

Most occur only in small numbers of individuals but several species of defoliators and flower or fruit eaters breed continuously on lantana, e.g., *Hypera ignotalis*, which has nine generations a year with a long cold weather brood. The regular breeders are prevented from increasing abundantly by wilt disease and parasites; they are also difficult to rear in an insectary on account of disease, and do not offer much scope for artificial multiplication.

The lantana seedfly, *Ophiomyia lantana*, was, we conclude, introduced to Bangalore in 1921 and has since spread over the whole country. It has 21 generations a year but is parasitised by 8 species of Chalcididae. Fruits attacked by the fly definitely germinate and the germination percentage is of about the same order as in unattacked fruits which is very low, less than 15 per cent. The fly cannot be regarded as a factor of importance in preventing the germination of fallen lantana berries. Nor is *Platyptilia pusillidactyla* of any value in checking the fruiting of lantana.

MIMOSA CHAMPACA INSECTS.

The champ bug, *Urostylis punctigera*, was maintained on caged trees in the insectary garden. In Dehra Dun it has the same habit as in Bengal of remaining very localised without a tendency to disperse in the nymphal stages. A preliminary search for other species of *Urostylis* and their natural enemies was made in Naini Tal division.

MORUS INDICA INSECTS.

The parasite, *Cedria paradoxa*, was reared on *Margaronia pyloalis*, a mulberry defoliator at Dehra Dun and colonies were transported to Changa Manga plantation, Punjab; 15,700 parasites were liberated in June and 20,600 in November.

A survey of the parasitism of *Margaronia pyloalis* in the irrigated shisham plantations of the Punjab was started and about 20 species were obtained but very few have yet been identified.

SANTALUM ALBUM INSECTS.

Large collections of sandal insects made in Salem district were identified for the Madras Forest Department. In material taken on field crops in several localities between October 1936 and January 1937, amounting to 7,200 specimens, Jussidae were poorly represented and Aphidæ and Thysanoptera were entirely absent.

Sticky paper traps each 3' x 4', exposed at heights of 3 to 8 feet in Noganur forest between October 1937 and January 1938 yielded over 5,000 specimens; these were dissolved out of the adhesive and the majority were identified. Thysanoptera comprised 55 per cent. of the total catch; aphids and jassids were rare.

Studies in the seasonal incidence and distribution of the Heteroptera of sandal were completed with the examination of the remaining 1,600 specimens, which added 25 species to the insect fauna of sandal. *Indian Forest Records* were published on the Lygaeidae, Dermaptera and Orthoptera.

No field work was undertaken by the Forest Research Institute.

SWIETENIA MAHAGONI INSECTS.

Very little could be done at the Nilambur insectary on *Hypsi-pyla robusta* without dislocation of the work on teak defoliators. In Nilambur the shoot-borer appears to be entirely free from parasitism. An egg-parasite, *Trichogramma minutum*, was multiplied and 6,000 were released in mahogany plantations. The data obtained in the Madras sample plots were examined.

Pagiophlæus longiclavis, the collar borer, was found to breed also in the thicker shoots of mahogany and its work is liable to confusion with that of *H. robusta* in sample plots. Collar borer attacked plants removed in control operations were regularly analysed at Dehra Dun and it was found that the majority of uprooted plants contains no living borers, emergence having occurred before detection.

TECTONA GRANDIS INSECTS.

Defoliators.—An insectary was maintained at Nilambur from 1st April 1937 to 28th November 1937 to study the defoliation of teak and the parasites of defoliators.

Through the courtesy of the Forest Department, Burma, their Forest Entomologist maintained an Insectary at Insein for the collection and despatch of teak defoliator parasites to Madras. Fifty-three lots were received at Nilambur transported in cold storage by ship between Rangoon and Madras and thereafter as railway parcels.

About 1,600 *Hyblæa puera* larvae were exposed in 11 experiments to 3 species of Burmese *Apanteles* but only one generation of parasites was reared and the remaining material was exterminated by bacterial disease of the host.

About 500 *pucra* larvae were used for 3 species of tachinids without establishing the parasites.

Brachymeria cuplax, *Cremnops desertor* and *Eucarcelia kockiana* were successfully imported but these species were found to be indigenous.

A species of *Trichogramma* was imported from Burma in 9 consignments and bred up on eggs of *Hapelia macharalis*, *Diacrisia obliqua* and a flou moth. Forty-eight experiments using 5,000 eggs were conducted and at the end of the work about 225 parasites were released.

Trichogramma minutum.—Material was obtained from wild egg masses of *Diacrisia obliqua* and from the Mysore Government Entomologist. Twenty-three generations were reared and 9,250 parasites were released at the end of the operations.

Cedrin paradora.—About 1,000 individuals were transported from Dehra Dun to Nilambur in March 1937 and over 5,000 cocoon-colonies representing half a lakh of parasites were produced in the insectary. As hosts for this breeding work 11,800 caterpillars were used. About 10,000 parasites were released in 11 localities in the Nilambur teak plantations and a colony of 500 was successfully shipped to Burma. Recoveries were made in two localities in September 1937 from an alternative host, *Lygropus quaternalis*, on *Helicteres isora*, and cocoons were found in April 1938 on fallen teak leaves attacked by *Hapelia macharalis* in a third locality.

The incidence of parasitism of *macharalis* (fifteen species) and of *pucra* (four species) between April and November 1937 was determined by regular sampling; 65 per cent. of the larval parasitism of *macharalis* was due to ichneumonids and 95 per cent. of the parasitism of *pucra* was due to tachinids. Bacterial disease was extensive.

Ecological surveys of the miscellaneous trees, shrubs and other vegetation in teak plantations have resulted in the compilation of lists of plants that are (a) desirable because they are food-plants of defoliators that are alternative hosts of parasites of *macharalis* and *pucra*, or (b) undesirable because they are alternative food-plants of *macharalis* and *pucra* or other pests of teak. Eleven of the desirable plants are factors in the control of *pucra* and 46 in the control of *macharalis*. Eight species are undesirable.

Borers.—Experiments in the control of *Phassus malabaricus* were undertaken by the Madras Silviculturist using an infestation

of *Trema orientalis*; plugging the borer hole with tar is a satisfactory remedy.

No reference was made in the report for 1936-37 to Dr. Beeson's visit to Burma at the close of the year to advise on entomological research and in particular on the beehole borer of teak, *Xyleutes ceramica*. His recommendations were adopted by the Burma Forest Department and the report was published during the current year.

BORERS OF NEWLY FELLED TREES.

The biology of *Platypus bifurcus* in *Pinus longifolia* was studied in the field in the United Provinces. Poles felled and barked in the winter were surface treated with Aseu in Chakrata division in April and by July were attacked by *P. bifurcus* except those that had dried out sufficiently to make them unsuitable for the development of the larvæ. Storage of poles in water or rapid drying in the sun are considered to be the best remedies.

In the Insectary many new records were made of borers of timbers from various parts of India and satisfactory progress was achieved in identification.

Poles and logs of *Bombax malabaricum*, *Dalbergia sissoo*, and *Shorea robusta* were felled and barked in Dehra Dun division in March and surface brushed with (a) cold Aseu solution and (b) the same followed by asphalt crude oil suspension heated to 50° C. In November all the treated material showed extensive damage by powder post beetles and (to a less extent) by pinhole borers and termites, demonstrating that surface treatment does not prevent boring by species of which the adult makes an oviposition tunnel within the sapwood.

BORERS OF ARMY TOPIS.

Topi pith helmets are attacked by *Rhizopertha dominica* owing to the use of flour paste. Various poisons for use in paste were tested. It was found that sodium fluosilicate, 10 per cent., is as effective as a 3 per cent. solution of arsenic pentoxide and copper sulphate, 3: 1, but is less satisfactory than a 3.5 to 4 per cent. solution of arsenic-copper. These poisons are more effective in protecting topi shapes in the factory than is the plain copper sulphate treatment at present used by army contractors.

TERMITES.

Information on the economic importance of termites has been collected from Forest Departments in accordance with the resolution

and questionnaire of the British Commonwealth Scientific Conference, London, 1936.

A project for the investigation of the biology and control of soil termites in collaboration with the Agricultural Research Institute, New Delhi, has been under consideration by the Imperial Council of Agricultural Research throughout the year.

PARASITES AND PREDATORS.

General studies have been continued. Special operations involving multiplication and colonisation of selected species are referred to under mulberry, shisham and teak insects.

BIOLOGIES.

The greater part of the biology of the Cerambycidae has been written up. Numerous local species of defoliators of trees were bred.

In the Dehra Dun Insectary 128 consignments of insect damage were received from forest divisions. 572 breeding cages were in operation. The total number of insects bred in the insectary was over 77,000, excluding the special parasite rearings and the yield of the field insectaries. 17,352 specimens were mounted and labelled.

Guides.—A Guide to the Insects of *Dalbergia sissoo* was prepared and sent to press.

Systematic Entomology.

IDENTIFICATION.

The staff of this section has been steadily occupied in arranging, identifying and summarizing data on the great numbers of insects reared in the insectary, collected on tour, or sent in by forest officers. Numerous specialists in other countries continue to give their assistance. The Imperial Institute of Entomology has arranged for the identification of parasites and considerable headway has been made already. Three hundred and fifty-one Indian species have been added to the reference collection.

TAXONOMY.

The collection of identified coleopterous larvae has been considerably extended by rearing experiments and several *Indian Forest Records* have been prepared for publication. A paper on

larvæ of Lymantriidæ, the first of a series proposed for immature stages of Lepidoptera, is in press; the necessary rearing experiments were carried out in the systematic Entomologist's laboratory.

Descriptions of 44 new species of *Crossotatus*, Platypodidæ, were published as an *Indian Forest Record*.

The collections have been maintained in good condition. A large collection of identified Coleoptera was presented to the Imperial Agricultural Research Institute, New Delhi.

Tours.—By Dr. Beeson to Dehra Dun division in October; to Delhi in November (Entomologists' Committee) and in March (Federal Public Service Commission); to Lahore (Sericultural Committee and shisham plantations) in December; to Ranchi (Indian Lac Cess Committee) in March. By Mr. Gardner to Almora East and West and Garhwal divisions in May-June; to Nilambur in July. By Mr. Mathur to Lahore, Montgomery and Multan divisions in May, June and November. By Mr. S. N. Chatterjee to Nilambur, April to November; By Mr. Bhatia to Almora East and West and Garhwal divisions in May, June and Chakrata divisions in July. By Mr. Bhasin to Saharanpur divisions in July.

Museums.—Numerous additions were made to the display of damage by wood borers and to ecological and parasitism exhibits in the entomological museum. Reptiles and skins were added to the zoological museum.

Library.—158 books besides periodical were added to the Zoological library during the year.

CHAPTER V.—UTILISATION BRANCH.

Wood Technology Section.

1. RESEARCH.

(a) Work in connection with the preparation of hand lens keys, supplemented with low power photomicrographs, for the identification of the more important commercial timbers of Assam and Bengal was continued throughout the year under review. About 81 timber specimens were received from the above provinces in this connection. The conversion of logs and the preparation of microscopic slides are well in hand.

(b) Considerable progress was made regarding the studies of the formation of growth rings in the wood of *Acacia catechu*, *Albizia lebbek*, *Bombax malabaricum*, *Cedrela toona*, *Dalbergia sissoo*, *Eugenia jambolana*, *Michelia champaca*, *Pinus longifolia*, *Shorea robusta*, *Svetenia mahagoni*, *Tectona grandis* and *Terminalia tomentosa*. About 118 fresh micro-blocks were taken from living trees and most of them were sectioned and studied. The Bengal and Madras forest departments, who are also interested in this investigation, have sent so far 60 and 63 micro-blocks respectively, from teak and mahogany trees. These specimens also are being cut and studied. The results of this investigation will be published shortly in two parts.

In *Terminalia tomentosa* the presence of an "initial" type of parenchyma was reported previously. During the year, further research regarding the origin, structure and distribution of this type of parenchyma was continued with a view to throwing further light on the subject.

(c) The anatomical study of the woods of the Indian Dipterocarps was much interrupted owing to the pressure of work from other more urgent enquiries and miscellaneous investigations.

(d) Little progress was made on the anatomical study of the woods of different varieties of *Terminalia tomentosa* for the same reason.

(e) A study of the relationship between the anatomical structure and the physical properties of teak (*Tectona grandis*) was taken up during the year. A new consignment of 107 specimens was received for examination. Each specimen has been cut longitudinally into two sticks for detailed microscopic examination as well as for

strength tests. In this connection, 428 blocks will have to be examined.

(f) The study on the woods of the Indian *Machaetia* was continued.

(g) A detailed investigation on the anatomical and physiological effects of resin tapping in *Pinus longifolia* has been started. The Wood Technologist made a short tour to see the technique of resin tapping prevalent at Gaikhet in Almora, and collected micro-blocks from tapped, acid treated, low yield and high yield trees. All the blocks have been cut and photographed. The comparative study of the various sections under the microscope is progressing.

2. IDENTIFICATION OF WOODS.

The services of the Section for the identification of woods were utilized as usual with advantage by railway officers, engineers, timber merchants, the Army Department, the Forest Department, jute mills, and various firms dealing with timbers in some form or another. The following are some of the more important and interesting investigations completed during the year:—

- (1) The North Western Railway received a supply of bottom boards from a firm, quite a number of which were suspected as being of some timber other than gurjun (*Dipterocarpus* sp.), which was the timber specified in the contract. Out of 781 boards under dispute, the railway accepted 99 as gurjun and from the remaining 682, groups of similar looking woods were made, and 76 specimens from these groups were sent to Dehra Dun for checking. Out of these 76 specimens only five proved to be gurjun. The remainder included no less than 21 different species.
- (2) In another case, the same railway purchased from another firm some eng (*Dipterocarpus tuberculatus*) bottom boards, and as a large number of them appeared doubtful, they sent 4 specimens, representing different groups, to Dehra Dun for identification. On examination, not one of them was found to be even a *Dipterocarpus* species.
- (3) The Factory Rationalization Committee, Army Headquarters, sent specimens of "dogwood" (obtained from the War Office in England) for examination, and wanted to know whether a similar wood grew in India, so that the committee might be helped in "investigating the

possibility of manufacturing in India certain fuse powders requiring the use of dogwood as a raw material for making charcoal". The samples of "dogwood" were identified as *Rhamnus* sp. From an anatomical point of view it was doubtful whether Indian *Rhamnus* species would serve the same purpose, so other possible Indian woods were suggested instead.

- (4) An Executive Engineer in Bihar received a supply of sal (*Shorea robusta*) and teak (*Tectona grandis*) under a contract, but before finally accepting the timber as such, he wisely sent specimens to Dehra Dun for the Wood Technologist's opinion. On examination they were found to be neither sal nor teak.
- (5) A Controller of Stores sent four samples of timber cut from a supply of bottom boards and asked for our opinion as to whether or not they were representative of the Burma gurjun known as *kanyin*. On examination, it was found that only two were correct according to the specification.

The total number of timbers identified as the result of enquiries during the year was about 320.

3. SPECIAL ENQUIRIES.

Some special investigations were as usual carried out on behalf of officers of the Forest and Railway Departments. Enquiries received under this head continue to increase and take up a great deal of time, as they are usually new problems with a variety of fresh factors involved. Some of the more important investigations are recorded below:—

- (1) *Sterculia urens*.—An investigation to determine the best method of tapping *Sterculia urens* (*karar*) for its gum, was started. A preliminary survey had to be made, to find out the nature and distribution of the gum ducts in the wood. In this connection both bark and wood had to be examined from tapped and untapped trees, and the results indicated the advisability of studying more blocks from living trees. A tentative programme has, therefore, been drawn up and the investigation will be continued. This enquiry was taken up on behalf of the Central Provinces and the United Provinces forest departments.

- (2) *Santalum album*.—The Chief Forest Officer, Coorg, sent 48 discs of sandalwood for examination, with a view to ascertaining whether the growth rings visible on the cross section indicated the correct age of the trees. The examination of the discs is almost complete, and the data are being analysed with a view to a note being issued on the subject.
- (3) *Shorea robusta*.—The Conservator of Forests, Bihar, sent sal poles to estimate the age by counting the rings, and incidentally also to ascertain, if possible, from the study of the wood structure, the effect of improved growth due to the trees being situated very near an irrigated area. As usual, the sal discs, on examination, showed irregular marks due to the presence of bands of gum ducts or of parenchyma cells, but neither of these structures could be traced as complete rings. The results obtained indicated that for some time to come, the possibility of finding out the age of sal trees by counting the so-called growth rings will have to remain an open question. Further, the comparative wood structure did not justify the conclusion that the wood produced from the irrigated areas was different from non-irrigated areas.
- (4) *Dipterocarpus macrocarpus*.—The Silviculturist, Shillong, Assam, sent a disc of hollong to find out the age of the tree by counting the growth marks on it. This specimen proved to be very interesting due to the presence of distinct growth rings. It may be noted here that usually growth rings are indistinct in hollong as well as in other species of *Dipterocarpus*. A report was sent indicating the age of the tree based on the ring counting.
- (5) *Michelia excelsa*, *Quercus lamellosa*, *Quercus lineata* and *Gmelina arborea*.—In response to an enquiry from the Central Silviculturist regarding the distinct visibility of growth rings in these species, various specimens of the Forest Research Institute collection were examined and following note was submitted:—*Michelia excelsa* shows distinct growth marks, but neither *Quercus lamellosa* nor *Quercus lineata* has prominent growth marks. In *Gmelina arborea*, growth rings are usually distinct and specimens from certain localities sometimes even show ring-porous characteristics.

- (6) *Aucoumea klaineana*.—The Officer in charge, Workshops, K. G. O., Bengal Sappers and Miners, Roorkee, sent a sample of wood from a folding boat for identification and to find out the cause of its failure. It was identified as *Aucoumea klaineana* which is sold in Europe under the trade name of Gaboon mahogany. Microscopic examination showed that the timber was badly attacked by fungus.

The total number of wood specimens examined in connection with special enquiries was 120 and about 450 specimens are still in hand.

4. EXAMINATION FOR DETECTING FUNGUS ATTACK.

As usual enquires sent for examination many wood samples suspected of having been attacked by fungus. The total number of wood specimens examined in this connection was 50.

5. INDEXING PERMANENT SLIDES AND PHOTOMICROGRAPHS.

During the year under review, over 2,300 permanent slides of wood sections were prepared and added to the authentic collection. The slides were prepared both from Indian and foreign woods and quite a large number were prepared from species not previously represented. For publication and exhibition purposes, 33 negatives, 391 photomicrographs and 12 enlargements were made.

6. COLLECTION OF AUTHENTIC WOOD SPECIMENS.

(a) *From India*.—As usual a good number of authentic wood specimens backed by herbarium material were received from the different provinces for research purpose and also for the Institute's standard collection.

(b) *From abroad*.—During the year altogether 284 wood specimens were added to the foreign collection. These were received from England, the United States of America, France, Brazil, Japan and Siam. To the donors our sincere thanks are due for helping the Forest Research Institute to make its collection of commercial timbers of the world as complete as possible.

7. DISTRIBUTION OF WOOD SPECIMENS.

In response to requests from abroad and various parts of India, 778 wood specimens were supplied to enquirers. Quite a number of these specimens were sent to schools and colleges for instructional purposes.

8. TRAINING.

The following officers received instruction in the Wood Technology Section with a view to their acquiring some knowledge of wood anatomy and wood identification :—

1. Mr. P. A. Wanaraks, Siamese Forest Service.
2. Mr. A. Ghaffar, Student Sleeper Passing Officer, Bengal Nagpur Railway, Calcutta.
3. Mr. R. Krishnamurty, Mysore Forest Department.

9. TOUR.

Mr. K. A. Chowdhury went on tour to Ranikhet and Garkhet in connection with the anatomical and physiological investigation on the effect of resin tapping in chir (*Pinus longifolia*).

Timber Testing Section.

SPECIAL INVESTIGATIONS.

1. The study of the effect of corrosive chemicals on the strength of wood was continued during the year under review, but tests were done on only one species, namely deodar (*Cedrus deodara*). This work is being carried out in co-operation with the Seasoning Section which does the actual soaking tests.

2. A small log of locust (*Robinia pseudo-acacia*) received from the Director of Agriculture and Allied Departments, North-West Frontier Province, was tested in order to find the uses to which this species could be put. Although the material was not sufficient for full scale tests, it showed that the timber might be of considerable value if it was available in commercial quantities. It could be used as a substitute for imported ash and hickory for tool handles of all sorts. It was also found to be suitable for sports goods, delicate turnery and bent work.

3. Full scale tests were done on one consignment of hoom (*Sacopetalum tomentosum*) received from Kanara Eastern division, (Bombay), under Project 1. The tests show that it might be a very suitable species for the manufacture of bobbins, and it could be used as a substitute for imported birch and beech for other purposes also. It is, in addition, suitable for making bentwood furniture, light sports goods such as badminton rackets, foot rules, pen-holders, brush handles and a variety of small turnery articles. The timber should prove valuable to Bombay Presidency, as large

quantities of bobbins are required every year by the textile industry. It is a species worth cultivating in suitable localities.

4. Timbers used in aircraft construction, and samples obtained from wooden parts damaged in accidents, altogether amounting to 13 consignments, were tested during the year for the Director of Civil Aviation in India. It is now the general practice to use for the repairs of aircraft only such consignments of timbers as have passed the check tests at the Forest Research Institute. The soundness of this procedure has become evident from the fact that large quantities of imported aircraft spruce had to be rejected by one firm as the sample specimens sent to Dehra Dun revealed considerable weakness and fungal attack when tested. These aircraft check tests now done at Dehra Dun will undoubtedly help to increase the air worthiness of Indian aircraft.

5. Apart from the above tests, special efforts are being made by the Timber Testing Section to find suitable Indian woods for aircraft construction and repair work. Himalayan silver fir and spruce were chosen first for testing, and 8 selected sleepers of fir and 11 of spruce were specially obtained from Dhilwan in the Punjab for this work. All the samples had, however, to be rejected as the material was found to be attacked by fungus. As spruce and fir grow very high up in the inner Himalayas it takes a long time for the timber to reach its destination in the plains, and conditions throughout the journey are usually favourable for fungus attack. If some means could be found to hasten the transport of selected fir and spruce sleepers, they could probably supply the demand for all the smaller sizes required in aircraft work. This small material constitutes 70 per cent. of the total timber used in aircraft work. The investigation is being continued and other species are under trial, as the prices paid for aircraft timber are very attractive.

6. An unusually large number of glue joint test pieces were submitted during the year by candidates applying for ground engineers' licences. Failures among candidates from the Aeronautical Training Centre, Ltd., New Delhi, have been high. It is necessary for applicants to pay more attention to the requirements of the specification and to the proper method of making joints in order to avoid failure.

7. With a view to revising the present grading rules for teak squares, the Officer-in-Charge made two tours to Moghalpura, Lahore, and took observations on 431 teak squares from Burma purchased by the North Western Railway and passed under the

new grading rules. The preliminary calculations have already been done. A report is under preparation and is expected to be ready in a short time.

8. In order to increase the utilisation of timber in structures and to simplify the work of timber designing, the Officer in Charge prepared charts for the design of timber beams. From these charts, the proper sizes of timber beams for any given conditions of span and loading, and for any given species, can be readily obtained without any calculation, by simply following the lines on the charts with a pointer. Before they were printed, the charts were shown to the officers of the Royal Engineers at Roorkee, and their opinion on them was asked. Their report was very favourable, and they have already requested that they may be allowed to reproduce the charts in the Military Engineering Service Handbook.

9. As a result of an enquiry from the Madras Forest Department as to the strength properties of palmyra palm, tests were made to find out the suitability or otherwise of palmyra poles for electric transmission. Several 20-foot poles were tested by preparing a special testing platform on the 100,000 lbs. Riehle testing machine. A palmyra pole consists of a hard durable outer wall with a very soft perishable core. In this respect it differs from a tree which usually has a heartwood more durable than the sapwood. Palmyra poles are practically hollow circular tapering cylinders, but they proved to be equal in strength to sal poles of similar outside dimensions.

10. 107 scantlings of Burma teak of various rates of growth were received from the Forest Economist, Burma, for studying the relation of growth to strength. The tests have been completed. A detailed anatomical study of the differences in the structure of the specimens is now being made by the Wood Technologist, and if sufficient data are available a report will be prepared about the variations of strength and the reasons therefor.

11. Special tests for the study on " Moisture-strength relations " of Indian timbers were started during the year in co-operation with the Seasoning Section, and considerable progress was made. One consignment of sissoo (*Dalbergia sissoo*) has been tested completely and another of rosewood (*Dalbergia latifolia*) is nearly finished. Small specimens of the timber are seasoned to different moisture contents in specially constructed chambers, having accurate control of temperature, and humidity, care being taken to bring them all to as uniform a condition as possible. They are

then tested in static bending, impact bending and compression, without allowing changes of moisture content to take place. Careful shrinkage observations are also made.

The work will be continued until a sufficient number of species have been tested, in order to find the true nature of the relation between moisture content and strength.

12. Special tests on deep beams were also started during the year, for determining the horizontal shear stress developed in bending, with a view to evaluating safe working stresses in horizontal shear for beams. Some differences of opinion have arisen among Indian engineers as to the value of the factor of safety for shear to be used in designing. The Timber Testing Section has so far adhered to its old custom of calculating the horizontal shear stress by applying a factor of safety of ten to the shear stress as obtained by tests on small clear specimens. This safety factor of ten is generally used in all laboratories where special tests on deep beams have not been made. Some engineers in India, however, considered that it was unnecessary to take such a high factor of safety, especially in view of the low factor of 7.7 recommended by the Forest Products Laboratory of Madison, United States of America, for a softwood species like southern yellow pine. As no data are available as yet in India, to defend either theory it was decided to make some special tests before introducing any change. Some tests have already been made on sal, and other tests in this connection are being undertaken as soon as timber is available.

13. As decided by the Utilisation Conference of March 1937, a study of the variation of the strength properties of sal (*Shorea robusta*) from important sal producing areas in India has been started. Some 10 or 12 consignments of sal from different localities are being obtained for this study. Tests on two consignments are already in progress.

14. A number of graphs were prepared for establishing relations between the different strength functions and the specific gravity of Indian timbers. Some interesting facts were obtained from this study. It has been noticed, for instance, that in bending, Indian species are slightly stronger in the green state than American species, although having approximately the same specific gravities, but the improvement in strength during seasoning is less than that for American species. The study is being continued and a publication will be issued in due course.

15. Some tests were made on tea chests submitted by the Assam Sawmills & Timber Co., Ltd., with a view to improving the exist-

ing design of these containers. The company appreciated the work and wrote as follows:—

“ $\frac{3}{16}$ inch thickness of panels was adopted as our standard as a result of your report and has given us every satisfaction since its adoption.”

ROUTINE TESTING.

During the year under review, tests were continued under Project 1 (Standard tests on small clear specimens), and Project 2 (Standard tests on structural timbers). Other routine tests such as glue adhesion, plywood, and tests of glue joints submitted by ground engineers for their licence examination, etc., were done as and when required.

NUMBER OF SPECIES TESTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1 . .	9	14	17	...
Project No. 2 . .	1	4	...	...
Project No. 0 . .	Under all heads . . .			93

The 93 consignments under Project No. 0, includes 43 consignments of glue joint test pieces submitted by ground engineers for their licence examination, as against 15 in the previous year.

NUMBER OF SPECIES COMPUTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1 . .	2	14	...	...
Project No. 2 . .	...	...	...	...
Project No. 0 . .	Under all heads . . .			51

List of Species tested under Project No. 1 during the year.

Species	From	Condition.
<i>Albizia odoratissima</i> (black albizia) . .	Colombatore, Madras . . .	Green and Kiln dry.
<i>Amoora rohilkha</i> (amoora) . .	Nowgong, Assam . . .	Air dry. (Second lot).
<i>Amoora walliehi</i> (amoora) . .	Katha, Burma . . .	Ditto.
<i>Artocarpus integrifolia</i> (Jack)—Hill grown.	S. Mangalore, Madras .	Green and Kiln dry.
<i>Artocarpus integrifolia</i> (Jack)—Plain grown.	Ditto . . .	Ditto.
<i>Balanocarpus utilis</i> . . .	Tinnevely, Madras . . .	Ditto.
<i>Bassia butyracea</i> (hill m'hus) . .	S. Andaman . . .	Air dry.
<i>Carallia lucida</i> (Syn. <i>Carallia integrifolia</i>) (manlawga).	Nowgong, Assam . .	Air dry.

List of Species tested under Project No. 1 during the year—contd.

Species	From	Condition.
<i>Chulrasia tabularis</i> (thickrass) .	Katha, Borneo	Air dry.
<i>Dalbergia cultrata</i> (Burma black-wood)	Burma	Green and Kiln dry.
<i>Dichopsis polyantha</i> (tall) (Syn. <i>Isanandra polyantha</i>).	Cachar, Assam	Air dry.
<i>Engelhardtia spicata</i> (moglaipoma) .	Ditto	Kiln dry.
<i>Eugenia</i> sp. (Jaman) . . .	Ditto	Ditto.
<i>Grevia testata</i> (si) alphusra) . . .	Kurseong, Neogal	Green and Kiln dry.
<i>Hardwickia pinnata</i> (pinoy) . . .	Mangalore, Madras	Ditto.
<i>Heterica</i> sp. (di)amin sundri) . . .	Cachar, Assam	Air dry.
<i>Heterophrogna razburghii</i>	S. Chanda, C. P.	Air dry and Kiln dry.
<i>Milletia pendula</i> (Hilawin)	Burma	Green and Kiln dry.
<i>Minusops litoralis</i> (bullet wood)	South Andaman	Air dry.
<i>Pentace griffithii</i> (thitai)	Tavoy, Burma	Air dry.
<i>Pocillonuron indicum</i>	N. Mangalore, Madras	Kiln dry.
<i>Pongamia glabra</i> (say) karanj)	E. Kanars, Bombay	Air dry.
<i>Pterocarpus santalinus</i> (red sanders)	S. Cuddapah, Madras	Air dry and Kiln dry (2 cons)
<i>Saccopetalum tomentosum</i>	I. Kanars, Bombay	Air dry.
<i>Stereospermum elonoides</i> (pidri wood)	S. Mangalore, Madras	Kiln dry
<i>Terminalia myriocarpa</i> (hollock) . .	Lakhimpur, Assam	Air dry.

List of Species tested under Project No. 2.

Species	From	Condition.
<i>Bassia latifolia</i> (mrhuia)	Jubbulpore, C P.	Air dry.
<i>Canarium strictum</i> (white diup) . .	Madras	Ditto.
<i>Machilus macrantha</i> (ladder wood) .	N. Mangalore, Madras	Ditto
<i>Pentace griffithii</i> (thitai)	Burma	Green.
<i>Pterospermum oerifolium</i> (hatti-psin).	Buxa, Bengal	Air dry.

About 15,000 mechanical tests and 20,000 physical determinations were made during the year. In addition to computing the routine tests, the computing office prepared a number of graphs and tables for the design of timber beams and for answering enquiries. Numerous computations for the revision of the existing grading rules for tenk squares were also made.

Wood Seasoning Section.

1. KILN DRYING RESEARCH WORK.

No fresh material for kiln drying experiments was received during the year, and whatever small stock of wood was in hand was reserved for special experiments in connection with the testing of the Furnace kiln. The kilns were therefore run on material received from the Wood Workshop and the Timber Testing Sections, and from some furniture makers in the town. The new metal-lined laboratory kiln was not found to be sufficiently air and moisture-proof, and certain experiments on kiln drying that had been planned had to be postponed till a second kiln on an improved design was constructed.

Salt Seasoning.—Experiments were carried out on *Terminalia tomentosa*, *Adina cordifolia*, *Albizia procera* and *Bassia butyracea* to determine whether the soaking of freshly converted material of these species in a solution of common salt prior to kiln drying had any effect on the drying properties of the wood but so far none of these experiments have given any positive results.

2. FURNACE KILN.

Five charges of wood were dried in the Furnace kiln during the year, all of which gave very satisfactory results. One of the charges consisted of 2-inch thick planks of axlewood (*Anogeissus latifolia*), which was dried from a moisture content of 37 per cent. to 10 per cent. in 19 days. This is a very refractory wood, liable to severe surface cracking during seasoning, but in this kiln both the speed and the quality of drying were excellent, there being no appreciable damage from cracking, warping and other causes. Other woods dried in this kiln during the year were *Dalbergia sissoo*, *Dalbergia latifolia*, *Albizia lebbek*, *Cedrela toona*, *Stercopermum chelonoides*, *Terminalia bialata* and *Terminalia tomentosa*. One inch thick planks of *Cedrela toona* were dried from an initial moisture content of 50 to 70 per cent. down to 10 per cent. moisture content in 9 days, without any collapse or any other degrade.

Improvements to the kiln.—In order to increase the humidity of air during the conditioning treatment at the end of a kiln run. a second water spray pipe was introduced in the kiln and a baffle plate was fitted to allow more intimate mixing of spray water with the hot furnace gases. This resulted in considerable improvement of the conditioning treatment, and it was found possible to

raise the relative humidity of the furnace gases to about 90 per cent. of saturation.

Comparison with ordinary kiln drying.—In the Furnace kiln it has been possible to employ higher temperatures and lower humidities than those found suitable for drying wood in an ordinary steam-heated kiln, with the result that the drying has been more rapid, without any apparent adverse effect on the quality of dried wood. In order to compare the drying of two charges of a wood, one dried with furnace gases and the other with air heated and humidified with steam, the Furnace kiln has been fitted with a steam heater and a steam spray pipe, so that any conditions of temperature and humidity can be maintained in the kiln. It is intended that one charge of one inch planks of sissoo (*Dalbergia sissoo*) will be dried in the kiln in the usual manner using furnace gases, and a second charge will be dried with hot air, the kiln being run on exactly the same wet and dry bulb conditions as before. The rate of drying of the two charges as well as the quality of dried material will be compared. The necessary alterations to the Furnace kiln are in progress.

Indirect heated Furnace kiln.—In the present Furnace kiln, hot combustion gases from the furnace come directly in contact with the wood to be dried, which results in a slight superficial discoloration of the dried wood. In order to overcome this defect, and also to simplify the construction and operation of a kiln of this type, it is intended to put up one or two kilns in which the furnace gases will circulate through sheet metal ducts to heat the air used for evaporating moisture from wood. Equipment for one kiln of this type is on order from Austria, and it is proposed to obtain in the coming year a ready built furnace from Germany for a second kiln of this type. There is a definite demand in this country for a very simple type of kiln, preferably requiring no steam and motive power, and costing not more than a thousand rupees to build. Efforts are being made to bring out a design which will meet these requirements.

3. COMMERCIAL INSTALLATIONS.

It is gratifying to report that considerable progress has been made during the year in the introduction of commercial kilns in the country. A firm in Calcutta, which started only two years ago with two small kilns, has now put up 4 more large sized kilns and these are being kept busy to their full capacity. A sawmill in Assam is putting up a battery of kilns with a drying capacity of 10 tons of sown material per day. Seasoning kilns are also

being put up at Hyderabad (Deccan), Shimoga (Mysore) and Madras. Designs for all these installations were drawn up and supplied by the Seasoning Section and the equipment is being made in the country. A plywood factory on the West Coast is constructing two tunnel driers for drying veneers according to design supplied by the Institute. A design for a furnace kiln was supplied to the Ceylon Forest Department, which, it is understood, is in course of construction, and a scheme for the alteration of one of the external blower kilns at the Gun Carriage Factory into an internal fan type of kiln was drawn up. This has been sanctioned by the authorities, and the alterations will be carried out during the coming year.

4. AIR-SEASONING.

Very little material was stacked for air-seasoning during the year, as the stock of timbers for Project VII was practically exhausted. Final observations on the following timbers which were stacked in previous years were taken :—

- (1) *Altingia excelsa*—6" × 4" scantlings.
- (2) *Anogeissus latifolia*—4" × 4".
- (3) *Artocarpus chaplasha*—1½" planks.
- (4) *Eugenia gardneri*—10" × 5" and 3" × 3" scantlings.
- (5) *Gmelina arborea*—1" and 2" planks.
- (6) *Heritiera minor*—3" × 3" scantlings.
- (7) *Hopea odorata*—½", 1" and 2½" planks.
- (8) *Hopea parviflora*—6" × 4" scantlings.
- (9) *Hymenodictyon excelsum*—1" planks.
- (10) *Ougeinia dalbergioides*—1" and 2½" planks.
- (11) *Quercus lamellosa*—6" × 4" scantlings.
- (12) *Quercus lineata*—6" × 4" scantlings.
- (13) *Stercospermum chelonoides*—2½" × 2½".
- (14) *Terminalia bialata*—1" and 2" planks.

Seasoning in scantling sizes.—A number of species were seasoned in the form of thick scantlings, and it was found that except for *Altingia excelsa* all woods up to 6" × 4" had dried thoroughly in 2 years' stacking under cover, but the thicker material, e.g., 10" × 5" beams of *Eugenia gardneri*, was still wet in the interior and required further drying. *Quercus lamellosa* and *Q. lineata* suffered very heavy degrade on account of surface cracking, heart shakes, collapse, warping, twisting and crookedness, but it must

be noted that out of the seasoned scantlings it is possible to obtain some good planks on re-sawing, while green conversion into thin sizes would have led to almost entire rejection of the whole lot at the end of the seasoning process. For some of these highly refractory woods, air-seasoning in the form of scantlings and re-conversion into plank material is obviously the best solution.

Closing up of cracks.—Another observation, which is not a new one, is that during the early stages of seasoning the surface cracks on wood open out very badly giving one an impression that the wood is practically useless for any purpose. When, however, the process of seasoning is complete, these cracks close up and become almost invisible, giving quite a contrary impression about the quality of the wood. While taking moisture tests from some of the well dried scantlings of *Anogeissus latifolia*, *Hopea parviflora* and other woods, it was noticed that what appeared like hair cracks on the surface, penetrated to a depth of one inch or more.

Girdling of deodar trees.—Two trees of deodar were girdled in the Chakrata forest division in October 1935, and were felled in May 1937. Two ungirdled trees of deodar were also felled at the same time to serve as controls. All the four trees were converted into broad gauge sleepers, which were brought to Dehra Dun for observation. The experiment is in progress, but no indication has so far been found to show any advantage of girdling of standing trees of deodar before felling.

5. WATER-SOAKING PRIOR TO AIR-SEASONING.

The material that was included in this test, which was started 4 years ago, was found to be of such poor quality that no useful results would have been obtained by testing the strength properties of the soaked and unsoaked specimens. The whole lot was, therefore, taken out of the water and the experiment was postponed till better material was available.

6. AIR-SEASONING OF RAILWAY SLEEPERS.

Seasoning experiment on chir sleepers.—An experiment on the air-seasoning of chir sleepers in the East Almora division of the United Provinces was started during the year in co-operation with the United Provinces Forest Department, The Indian Turpentine and Rosin Co., Ltd., and the Sleeper Control Officer, Northern Group. The experiment is planned to study the seasoning of chir sleepers from the time they are cut, right up to the time they are used, in order to obtain definite information on the amount

and nature of seasoning defects, and the rate of dying of sleepers at various stages of seasoning. It is expected that the information obtained from this investigation will enable us to suggest ways and means of improving the seasoning of chir sleepers, as well as of minimizing seasoning degrade, which is a cause of heavy rejections at the time of passing. The experiment was divided into two parts. Two thousand sleepers were selected in the forest for stacking in the winter months, October to January, and one thousand sleepers were taken under observation in the hot season, *i.e.*, in the month of April. The experimental sleepers were stacked at the launching depôts in the close crib manner, the stacks having been covered with thatch. Before stacking, the sleepers were weighed, their condition noted, and a complete record, showing the position of each sleeper in the tree, the size of the tree, and the slope of the hill, etc., was made. The observations with regard to weight and the condition of the sleepers will be taken again, first at the time the sleepers are launched, and again when they arrive at Tanakpur and finally at the time of passing.

Effect of tarring.—As end-cracking is the most serious defect in chir sleepers, and as tarring the ends of sleepers in the forest has proved beneficial in the case of softwood sleepers extracted from Kulu and Seraj divisions in the Punjab, three thousand chir sleepers in the East Almora division were end-painted, half the number with thick coal tar and the other half with chir tar. The amount of end-cracking of these sleepers will be observed at the time of passing and compared with other sleepers from the same area which have not been given any end-coating.

Log seasoning.—As mentioned in the last year's report, the effect of seasoning in log form is also included in this investigation. Twenty trees of chir were felled in March 1937, and the logs were allowed to season in the forest. Sleepers obtained from these trees have been marked separately and their behaviour will be observed along with the other experimental sleepers.

Sal sleepers.—Reference is made in the last year's report to a seasoning experiment on meter gauge sal sleepers, started in co-operation with the Rohilkund and Kumaon Railway, near Lucknow. The stock of 500 sleepers under seasoning was examined, as also the sleepers laid last year in the line in green condition. It was observed that the sleepers stacked for seasoning showed a little more cracking than those in the line, which were covered heavily with ballast, but it is yet too early to pass any definite opinion on the investigation.

Madras hardwood sleepers.—During the course of a tour to Madras, the Officer in charge of the Section accompanied Mr. M. A. Hafiz, the Assistant Forest Utilization Officer, Madras, to see the passing of hardwood sleepers of teak, irul (*Xylia xylocarpa*), nangal (*Mesua ferrea*) and vumbogum (*Hopea parviflora*) for the South Indian Railway, in order to observe the defects to which each species is liable. It is proposed to start an experiment on the seasoning of hardwood sleepers on the West Coast of Madras, and a detailed scheme is being drawn up for the purpose.

7. ELECTRIC MOISTURE METERS.

The variation of electrical resistance of wood with moisture content is being studied for some of the commercially important species of Indian woods. The results so far obtained indicate that Indian woods can be divided into two groups, one having a relatively higher resistance than the other. The study is still in progress.

Many enquiries were received for the electric moisture meters, and it is understood that five more meters were sold during the year by Messrs. R. Mukerjee & Co., who have been entrusted with their manufacture.

8. WOODS FOR SHUTTLES.

An important investigation has been started to find out indigenous woods suitable for hand and power loom shuttles. The woods required for the purpose are naturally hard and refractory and their proper seasoning before use is imperative if good results are to be obtained. There are only two commercial concerns in the country engaged in the manufacture of shuttles, and the only wood used for the purpose is cornel wood imported from America. A large number of Indian woods have been tried, but all of them have been reported on as unsuitable, chiefly on account of the lack of proper seasoning before use and also for want of selection of material, which is very necessary, as the blocks for this work should be entirely free from cracks, shakes, splits, knots and other defects. It has now been arranged to obtain from various forest departments woods which are considered suitable for the purpose in the form of logs, which will be converted and seasoned at the Institute, cut into blocks of proper size, and the selected material free from defects sent for a manufacturing trial to the two shuttle factories who have expressed their willingness to co-operate in this investigation. Indian boxwood (*Buxus sempervirens*) and parrotia (*Parrotia jacquemontiana*) have been found suitable for

handloom shuttles and efforts are being made to arrange supplies of these woods from various sources. Blocks of kiln dried *Anogeissus latifolia* have already been sent to a firm in Bombay. *Ougeinia dalbergioides* is also under seasoning at present for this investigation and supplies of other woods are soon expected.

Similar investigations for specialized woodworking industries, such as tool handles, picking arms, jute mill rollers, shoe lasts and heels, etc., will be taken up in the coming year.

9. WOODS FOR BATTERY SEPARATORS.

Numerous enquiries are being received on the subject of Indian woods considered suitable for battery separators. These are at present being imported from America, and are made of Port Orford cedar. An investigation has been started to find out which Indian woods can be used for this work. Battery separators will be made of various Indian woods and their life will be tested in actual use in a number of batteries which will be set up in the laboratory and alternately charged and discharged for a period of about one year.

10. MOISTURE EQUILIBRIUM SURVEY.

This investigation was started in 1936, and the observations will be continued up to June 1938. A report on the investigation will be issued in the coming year.

11. SHRINKAGE STUDIES.

As in the previous year, a large number of shrinkage specimens were kept under observation during the year. Detailed studies are being made of the shrinkage of wood from the green to the air dry condition, as well as the changes in the dimensions of seasoned wood due to fluctuations in atmospheric humidity. The following new species were taken up during the year:—

- (1) *Adina cordifolia*.
- (2) *Lagerstrœmia hypoleuca*.
- (3) *Albizzia procera*.
- (4) *Burus sempervirens*.

Shrinkage will be determined on small clear specimens as well as on plank material.

Shrinkage retarding treatments.—Tests on synthetic resins (Durez) received from America and also on the resins formed with furfuryl alcohol-furfuraldehyde mixture by the action of strong

mineral acids were started during the year. Small specimens of the following species were impregnated with resins and their shrinkage at various humidity conditions determined:—

- (1) *Adina cordifolia*.
- (2) *Bombax malabaricum*.
- (3) *Dalbergia ussoo*.
- (4) *Sterculia campanulata*.

12. END PAINTS.

End painting of small sleeper pieces of deodar was carried out with the following paints:—

- (1) Hardened gloss oil.
- (2) Paraffin-rosin mixture.
- (3) Coal tar.
- (4) Three special paints received from Germany.

The moisture-proofing quality of the above paints is also under investigation.

13. EFFECT OF CHEMICALS ON WOOD.

The work on the effect of various chemicals on wood described in last year's report was continued. Static bending tests have also been included in this investigation.

14. ENQUIRIES.

The number of enquiries received in this section is increasing yearly and over 130 enquiries were dealt with during this year. Designs of seasoning kilns were supplied to more than 25 enquirers.

Wood Preservation Section.

This section functioned on a reduced scale during the year under review, owing to the transfer of the Officer-in-charge to the Timber Development Branch.

The following items of work were investigated during the period under review:—

1. OPEN TANK TREATMENT WITH ASCU.

An open tank method was worked out for treating certain types of wood efficiently with Ascu. The operation is carried out in two tanks—one containing plain water for heating the timber to be treated, and the other containing cold Ascu solution for use

after the wood has been heated in the water. This double tank method of treatment appears to give very good results in the case of small round sapwood timber such as fence posts. It is not applicable to square or sawn heartwood timber.

2. SERVICE LIFE OF TREATED AND UNTREATED TIMBERS.

(a) A new small demonstration test yard was prepared for showing to visitors the effectiveness of various methods of wood preservation and the efficiency or otherwise of different wood preservatives. Some 160 sapling billets (2' 6" long) have been installed in it. They were treated with Asen and creosote-crude oil mixtures using various methods of treatment.

(b) A few small tests, especially as regards splitting, were started on creosoted and Asen treated shingles of various species of timbers by fixing them as a demonstration roof. Some treated shingles were also sent to the Andamans for test in a similar way.

(c) Some 21 ft. poles and some fence posts of chir pine (*Pinus longifolia*) and sal (*Shorea robusta*) were treated with Asen and a creosote-fuel oil mixture and were installed in the new demonstration ground with a view to comparing the life of such poles treated with these two preservatives. Similar poles of some other species are at present undergoing seasoning and will be installed during the coming year.

3. FIRE-PROOFING TESTS.

Many fire-proofing chemicals and their mixtures have been tested from time to time at Dehra Dun, but most of them seem to have deficiencies or are very expensive. As a result of this research it is hoped that a cheap fire-retardant paint has now been evolved. Experiments are continuing to improve it still further.

4. GRAVE-YARD TESTS.

(a) The following proprietary boards and wood preservatives were put to test in the "grave-yard" for testing against termites and fungi:—

- (1) Heraklith boards (Asen treated and untreated).
- (2) "Flexo" plywood.
- (3) "Tentest".
- (4) Asplund impregnated wall-board.
- (5) Wood fibre boards.

(6) " Porcella " paint.

(7) Magnesium oxychloride.

(b) Specimens of the following untreated species of timbers were also put under test in the test-yard:—

(1) *Engelhardtia spicata*.

(2) *Pentace griffithii*.

5. An official Forest Record on Ascu was prepared and sent to the Press. Taken as a whole the possibilities of Ascu continue to look promising. The preservative has now been under test for 5 years and the results are encouraging, but several years more must elapse before it can be accepted as efficient in all respects for use as a wood preservative in India.

6 PENETRATION OF PRESERVATIVES INTO WOOD.

During the year under review, work on the movement of preservatives in wood, with special reference to various problems connected with Ascu and creosote, was started. A comparative study of the absorption of water, Ascu and dichromate by chir blocks (end penetration being avoided) showed that, under identical conditions, the blocks absorbed 77 per cent. of their weight of water, 26 per cent. of Ascu 4 per cent. solution, and 25 per cent. of 4 per cent. dichromate solution. The period of soaking was five weeks. When tested for compressive strength, there was no difference between the Ascu treated and water soaked pieces. Preliminary studies on the rate of flow of Ascu solution through transverse sections of chir showed that these sections are less permeable to Ascu than to water. The work is being continued. Other work to investigate the cause of the erratic permeability of chir to preservatives is also in progress.

Work on a further series of experiments on the mechanism of the fixation of Ascu in wood was also started during the year. The work in this connection is being continued, and the effect of soil salts, etc., on the leaching of Ascu is also being investigated.

Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other Sections, while the Officer-in-Charge devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 14,662 wood specimens for test purposes as detailed below:—

Static Bonding—	
Research—1R	115
1Spl.	40
Regular—1	1,477
Vehicle minor—1VM	679
Plywood—1PW	109
Impact Bonding—	
Special—2Spl.	53
Regular—2	1,101
Royal Aircraft—2RA	1,749
Compression Parallel—	
Structural—3Str.	48
Regular—3	2,636
Compression Perpendicular—	
Structural—4Str.	21
Regular—4	693
Hardness—5	707
Shearing—	
Regular—6	2,408
Plywood—6PW	446
Glue Joints—6JB	120
Tension Perpendicular to grain—7	690
Torsion—8	513
Shrinkage Radial and Tangential—9	548
Shrinkage Volumetric—10	214
Hammer Handles—1H	33
2H	34
Aircraft—1A	173
Boxes	32

The Wood Technology Section was supplied with 91 “Gamble” specimens, 1,075 hand specimens and 6 cubes for specific gravity tests.

In addition to supplying other Sections with converted material for research purposes, this Section completed 361 jobs of a varied character.

Reports on the working qualities of the undermentioned timbers were recorded during the period under review:—

Myristica spp.

Heterophragma roxburghii.

Isonandra spp.

Carallia integerrima.

Sageræa laurina.

Heritiera spp.

Pongamia glabra.

Pentace griffithii.

Terminalia myriocarpa.

Saccopetalum tomentosum.

ENQUIRIES.

Various enquiries in connection with wood working and related subjects (other than veneers, plywood and glues) were received and dealt with.

TESTS.

Tests were carried out on "Corroid" Mastie Composition for laying parquet floor blocks with a view to ascertaining its suitability under the climatic conditions prevailing in India. The blocks are still under observation.

Tests on the working qualities of *Robinia pseudoacacia* were carried out on behalf of the Director of Agriculture, North-West Frontier Province, and the results reported.

An experimental floor (using casein cement of our own formula) was laid during the year and is under observation. So far it does not appear to be so satisfactory as some other parquet floors laid with bitumastics.

Project VIII tests were carried out on a log of *Dalbergia sissoo* on behalf of the Divisional Forest Officer, Peshawar Forest division, and the results were reported.

TRAINING.

Courses of training in Saw-doctoring were given to 6 selected soldiers from the King George V's Own Bengal Sappers and Miners, Roorkee, during the year under report.

VENEER SUBSECTION.

The officer in charge was on long leave from 25th March 1937 to 9th November 1937. On his return from leave, logs of the following species were peeled for test under Project VIII:—

Pinus longifolia.

Boswellia serrata.

Cedrus deodara.

A great many enquiries relating to veneers, plywood and glues were received and dealt with during the year. This subject appears to have attracted considerable attention recently, but the starting of plywood factories in India is greatly handicapped by insufficient supplies of suitable woods in most districts. At the same time, it is satisfactory to be able to record that one new plywood factory in Madras started production during the year, and there are signs that other factories will be inaugurated during the coming year.

Considerable interest has also been shown in veneers and laminboard production, and it is hoped that before long the manufacture of these two wood products in India will be an accomplished fact.

Minor Forest Products Section.

The work of this Section has been reduced to answering enquiries and to carrying out the necessary routine work of the Section.

1. F. R. I. PORTABLE CHARCOAL KILN ("FRIKILN").

There has been a large demand for the scale drawings of this kiln from Divisional Forest Officers and charcoal contractors in various Provinces and States in India and also from foreign countries.

Replies to an enquiry made from all those who were supplied with the scale drawings of the kiln elicited the fact that more than 25 kilns are now working in various parts of India, and that the cost thereof ranged from Rs. 290 to Rs. 525. All users reported that the kilns were working satisfactorily.

2. CHARCOAL BRIQUETTING.

A note embodying the results of the experiments on charcoal briquetting with different binders was published in the "*Indian Forester*" of February 1937.

3. CULTIVATION OF MEDICINAL PLANTS.

The following drugs and herbs were grown successfully in the Minor Forest Product garden:—

Asparagus adscendens, *Asparagus gracilis*, *Ala vera*, *Aconit salamus*, *Ancilema scapiflorum*, *Curculigo orchoides*,

Datura metel, *Plantago lanceolata*, *Thalictrum foliolosum*, *Urginea indica*, *Vernonia anthelmintica* and *Withania somnifera*.

The following plants, namely,—

Anthemis nobilis, *Atropa belladonna*, *Bryonia alba*, *Digitalis purpurea*, *Digitalis lutea*, *Digitalis ambigua*, and *Saponaria officinalis*

were grown from seeds received from foreign countries supplied through the Forest Botanist. Germination was good and the plants are all growing well up to the time of report.

4. KARAYA GUM (*Sterculia nrens*).

Information on the method of tapping, uses, markets and prices was supplied to Provincial Forest Departments and various private firms.

5. PRODUCER GAS FROM WOOD AND CHARCOAL.

There has been a number of enquiries on this subject and such information as was available was supplied to all enquirers.

6. VISIT.

Col. R. N. Chopra, I M.S., of the School of Tropical Medicine and Hygiene, Calcutta, and Mr. S. N. Bal, Curator, Industrial Section of Indian Museum, Calcutta, paid a visit to the Institute during the year, and were specially interested in the Minor Forest Products garden and the work on drug cultivation going on.

The senior students of the Ayurvedic College, Gurnukul Kangri University, also paid a visit to the Institute during the year to see the Minor Forest Products garden and to obtain information as to the different medicinal plants of their own districts.

Paper Pulp Section.

I. EXPERIMENTAL FACTORY.

1. Experiments on *Saccharum munja* (munj grass), sent by the Radhasoami Satsang Sabha, Dera Ismail Khan, were completed. Satisfactory qualities of writing and printing papers were prepared from the grass. It appears from the results of the experiments carried out that this grass can be utilised for the manufacture of paper on a large scale, provided it is available at a cheap price.

2. Experiments on *Cymbopogon coloratus* (botha grass-), sent by the District Forest Officer, South Cudapah, were completed. The large scale tests confirmed the previous laboratory results, viz., that the fibre of the grass was very short, that the bleached pulp obtained from it was not very clean and that papers, of cheap qualities only, could be produced from it in admixture with some long fibred pulp, such as bamboo pulp.

3. Experiments were carried out on the production of kraft paper from *Dendrocalamus strictus* (salia bamboo) from Orissa. The paper produced lacked strength, due primarily to the Institute not having suitable beating equipment for kraft and to insufficiently heavy press rolls on the small experimental paper machine.

4. Experiments were made on the production of mechanical pulp from (1) *Broussonetia papyrifera* (paper mulberry), (2) *Pinus longifolia* (chir) and (3) *Picea morinda* (spruce), and the various factors affecting the grinding of wood were studied. The pulp produced was short fibred and brown in colour, and the papers prepared from the three kinds of pulps were rather poor in quality. A more intensive study of the grinding process, with special reference to the preparation of mechanical pulp from various Indian woods, has been started.

5. The erection of the new digester was completed. When work was started, the circulation of the liquor from the bottom upwards was found to be unsatisfactory. Steps have been taken to rectify the defect.

6. Rai Bahadur H. N. Batham, retired Agricultural Chemist, United Provinces Government, was accorded special permission by the President to investigate the possibility of preparing pine wool (a packing material) from chir needles. As the experiments were started too late in the year, pine needles of satisfactory quality could not be collected. In addition, mainly due to defective machinery, the experiments were not satisfactory. Mr. Batham hopes to start another series of experiments on a larger scale next year.

7. About two tons of writing, printing, type and packing papers and mounting and drying boards and about 7 cwt. of newsprint papers were produced during the year on the experimental paper machine. About 3½ tons of papers, boards and pulp were supplied to the various offices of the Forest Research Institute and College, the Government of India Press, Provincial Silviculturists, the Archaeological Chemist to the Government of India, and other officers.

II. LABORATORY.

1. The following grasses were tested as to their suitability for paper making:—

- (a) Five samples of *Saccharum arundinaceum* and *Saccharum spontaneum* from Sind. The stems of *S. arundinaceum* gave a satisfactory yield, whereas the yields from the leaf-stalks of *S. arundinaceum* and *S. spontaneum* and from the stems of *S. spontaneum* were poor. As the leaf-stalks and stems of the two species were sent separately, the yields from the whole culms of the grasses could not be arrived at and no definite conclusions could be drawn.
- (b) *Kaia* grass from Benares. The bleached yield from this grass was poor and the consumption of chemicals rather high. The grass, therefore, was not considered suitable for the manufacture of paper.
- (c) *Andropogon contortus* from Rewa State. The consumption of chemicals, yield of pulp and the fibre length indicate that the grass is suitable for the production of pulp and paper.
- (d) Four samples of *Anthistura gigantea* (ulla grass) from Mailani range, United Provinces. The samples were obtained from four different areas, viz., (1) highlands, fire-protected, (2) lowlands, fire protected, (3) highlands, non-fire protected and (4) lowlands, non-fire protected.

The samples from highlands gave higher yields of pulps than those from lowlands, but the difference in yields from samples from fire-protected and non-fire-protected areas was only slight. In the case of samples from lowlands, the non-fire protected sample gave higher yield than the fire-protected sample. As definite conclusions could not be arrived at from the experiments, it is being arranged to carry out large scale tests on this grass in the Paper Mills at Lucknow. A consignment of the grass from the areas from where it can be exploited on a large scale has been supplied to the Lucknow Paper Mills.

2. *Production of kraft paper*.—A series of experiments were carried out to determine the optimum conditions for the production of kraft papers from (a) *Dendrocalamus longispathus* and (b) *Pinus longifolia* (chir pine). The maximum breaking length, which could be attained for the sample sheets was slightly over 10,000 meters in the case of bamboo, and 9,000 meters in the case of chir.

The minimum breaking length in the case of chir papers was slightly over 4,000 meters. The tear and burst factors in the case of both bamboo and chir papers compared favourably with those of the corresponding imported kraft papers. The experiments show that under favourable conditions of treatment, satisfactory qualities of kraft papers can be prepared from bamboos and chir.

3. The following two materials were tested and found unsuitable for paper making, due mainly to shortness of fibre-length:—

(a) Cashew nut wood from Cochin and (b) Arrow-root stems, green and dry, from Darjeeling.

4. The investigation into the causes of the discolouration of pulps has been held in abeyance for some time, pending the appointment of a chemist.

5. Routine analytical tests in connection with the softening of the boiler feed water were carried out, as and when required.

III. INVESTIGATIONS ON BAGASSE ON BEHALF OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

The defibrator, hand-moulds and the dryer press were erected, and experiments on the production of insulation and wall boards were started towards the end of the year under report. A brief account of the work done and samples of the boards prepared were submitted to the meeting of the Sugar Committee of the Advisory Board of the Imperial Council of Agricultural Research held in Delhi on the 7th March 1938. The sound and heat insulation properties of the boards will be tested as soon as the apparatus, which has recently been obtained, is fixed up.

IV. TOURS.

1. At the request of Messrs. The Mysore Paper Mills Co., Ltd., Mr. Bhargava visited Bangalore and Bhadravati in September 1937 to discuss certain matters connected with the erection of the mills at Bhadravati.

2. The services of Mr. Bhargava were placed at the disposal of the Cochin and Travancore Governments for a period of about 5 weeks in September-October 1937 to investigate the possibilities of manufacturing pulp and paper in those States.

3. In December 1937 Mr. Bhargava advised Messrs. The Upper India Copper Paper Mills, Lucknow, regarding some new machinery for the mill and the layout of the projected extensions.

V. TRAINING OF APPRENTICES.

1. Dr. H. S. Sharma of the Mysore Paper Mills Co., Ltd., worked in the section from 15th April 1937 to the 13th July 1937.

2. The two Siamese students, Nai Sawai Supayaseimesri and Nai Pairojna Dharmatcha, completed their course of training on the 15th July 1937.

3. Three apprentices of the Mysore Paper Mills Co., Ltd., (1) Mr. N. S. Narayana Setty, (2) Mr. A. Krishnamurthy and (3) Mr. D Venkataramiah, attended the course of training from the 1st July to the 1st November 1937.

4. Mr. D. P. Bhargava of the India Paper Pulp Co. attended the course of training from the 2nd August to the 20th November 1937.

5. Mr. Vidya Bhusan Rastogi of the Rohtas Industries, Ltd., attended the course of training from the 1st September 1937 to the 31st January 1938.

6. Mr. Krishnamurthy was deputed by the Punalur Paper Mills Co., Ltd., for four months' training from the 21st January 1938.

7. Mr. S. S. Bhasin was deputed by Messrs. The Deccan Paper Mills Co., Ltd., for four months' training from the 25th January 1938.

VI. GRANTS.

The Paper Makers' Association, Messrs. The Upper India Couper Paper Mills Co., Ltd., and Messrs. The Mysore Paper Mills Co., Ltd., contributed during the year Rs. 3,250, Rs. 250 and Rs. 500 respectively towards the paper pulp research expenses at the Institute.

Mechanical Sub-Section.

Most of the machines of the Wood Workshops and the Veneer shop, including the A. C. & D. C. electric motors were repaired and thoroughly overhauled during the year.

The electric wiring of the 75 H.P. motor in the saw-mill and some other electric motors was renewed.

The Disintegrating Machine, together with the electric motors and starter, was erected in the Paper Pulp Section.

The new digester, with a pump and a 10 H.P. electric motor, steam and water pipe lines, was also erected in the same section.

New apparatus for preparing distilled water was erected, and several alterations and improvements were made to the wood pulp

grinding machine in order to improve the screening and application of load.

A new precision lathe for fine work was erected in the Iron Workshops.

The Ford and Chevrolet buses were overhauled during the year, and a new battery ignition system was fitted to the Fiat lorry.

The electric wiring for the new sound absorption test apparatus was completed. In addition to the above special work, all the electric motors, A. C. & D. C. generator sets, main switch boards, switchgears, electric wiring installations, Government lawn mowers, fire extinguishers and fire hydrants, light railway lines and trucks, etc., were maintained in proper order throughout the year.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report:—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs—

- (i) *Vitex peduncularis*, Wall.
- (ii) *Beilschmedia Brandisii*, Hook.
- (iii) *Senecio chrysanthemoides*, DC.
- (iv) Fish poison plants.

B.—Oils and Fats—

- (i) *Actinodaphne angustifolia*, Nees.
- (ii) *Litsea citrata*, Bl.
- (iii) *Bauhinia variegata*, Linn.
- (iv) *Solanum indicum*, Linn.
- (v) *Ximenia americana*, Linn.

2. Forest soils.

3. Miscellaneous enquiries.

1-A. *Drugs*.

(i) *Vitex peduncularis*, Wall.—Preliminary examination of the leaves obtained from Santa range (Bihar) showed, as was reported last year, the presence of an amorphous glucoside and traces of a basic substance of the nature of an alkaloid. Further samples of the leaves (obtained from the Forest Utilization Officer, Assam; and Southern Range Officer, Sibsagar division) were examined and these gave a small quantity of an amorphous glucoside, some amorphous acids, a neutral substance m.p. 112°-113° C., a light yellow crystalline substance m.p. 262°-263° C. and traces of an alkaloid.

The yellow crystalline substance m.p. 262°-263° C. is fairly soluble in water, but sparingly so in rectified spirit and insoluble in other common organic solvents. It appears to resemble vitexin which has previously been isolated as the hydrolytic product of the glucoside of *Vitex litorea* (Perkin, J. C. S., 1898, 1019) and of *Saponaria officinalis* (Barger, J. C. S., 1906, 1210). In the case of *V. peduncularis* it has not been possible to isolate the parent glucoside and it appears that vitexin is present in a free

state, since it is obtained from the aqueous extract of the alcoholic extract of the leaves, without any acid or alkali treatment.

In collaboration with the School of Tropical Medicine, Calcutta, its pharmacological properties are being investigated and till the results are ready it would be difficult to say if vitexin is the active principle of *V. peduncularis* and is responsible for the curative value of the plant in black water fever. In any case, no other constituent has yet been isolated which may appear responsible for the above virtues. The quantity of vitexin that is isolated is very small.

(ii) *Beilschmedya brandisii*, Hook.—This drug from Assam has a local reputation and use in chest complaints. Preliminary examination of the powdered air-dried bark, with 13 per cent. of moisture, gave the following amounts of extracts on being successively treated with solvents:—petroleum ether 0.75; sulphuric ether 0.45; chloroform 0.1 and alcohol 11 per cent. Of these, only the ether extract has given a small quantity of a crystalline material, which is being examined further. A small quantity (0.015 per cent.) of an amorphous alkaloidal substance is also present.

(iii) *Senecio chrysanthemoides*, DC.—In a previous report presence of two alkaloids in senecio from Kashmir was reported. Identity of the alkaloid m.p. 120° C. is still obscure but the other melting at 223°-224° C. was shown to be identical with Jacobine isolated by Manske from *Senecio jacobea*. Doubts have been thrown on the purity of the material investigated by Manske and according to Barger and Blackie (J. C. S., 1937, 554) Jacobine from *S. jacobea* is a mixture of two alkaloids Jacobine m.p. 212° C. and Jacodine m.p. 217° C. The work on these alkaloids is in progress.

Some other workers have reported the variation of alkaloidal content in *Senecio* sp. with season, but the following results show that such is not the case with the Indian species; July, August and September collections all giving 0.27 per cent. of crude alkaloids.

(iv) *Fish poison plants*.—During the year, the exploratory work on fish poison plants has been carried on. The object of this investigation is mainly to discover such indigenous plants that possess the toxic constituents namely rotenone and allied bodies, which are found in derris, loucheorampus and cube of trade; and to determine how far India can be a source of supply of vegetable insecticides of the type of derris for which there is a demand and a valuable trade. Bearing in mind the fact that trade is always conservative and is unlikely to accept plant materials that do not

contain rotenone, attention is being directed to those plants only that contain these products. The investigation of fish poison plants that might happen to contain potent insecticides other than rotenone and allied bodies will be taken up later.

For the above exploratory work, a list of Indian plants reputed as fish poison has been compiled.

Since all the plants that have hitherto yielded rotenone belong to the Natural Order Leguminosae, in our exploratory work attention is being concentrated on this natural order. A preliminary examination of the following has been carried out during the year:—*Cleisanthes collinus* (bark), *Albizzia procera* (bark), *Acacia pennata* (bark), *Pongamia glabra* (roots), *Pithecolobium bigenonium* (seeds), *Rauvolfia dumetorum* (seeds and pulp), *Mimosa himalayana* (bark), *Entada scandens* (seed husk) and *Tephrosia* sp. root-bark, leaves and seeds. All of the above plants have given varying amounts of ether solubles but none of them, except *Tephrosia candida*, gave any rotenone.

It is a matter of satisfaction to report the occurrence of rotenone in *Tephrosia candida*, DC. Following the usual method of extraction it has been possible to isolate 0.35 per cent. of rotenone from the root-bark and 0.5 per cent. from the seeds. The leaves also contain rotenone or allied bodies, as indicated by the usual colour reaction, but it has not been possible to isolate rotenone from them, in a pure state. The root-bark extract of *T. purpurea* also has given positive colour test for rotenone but the amount present is small, perhaps less than 0.3 per cent.

Some of the foreign species, *Caraca* (*Tephrosia*), *virginiana* of United States of America (*Scientific American*, 1933, 231) and the East African *T. macropoda* have been reported to contain rotenone and have been declared to be of value as insecticides. Indian *Tephrosias* occur in great abundance in some of our forests and the fact that such plants growing wild and of uncertain age have yielded 0.3-0.5 per cent. rotenone, is a matter of considerable importance and economic value, since it might be possible to improve the toxic constituents by care and cultivation.

Rotenone, along with the fatty oil, is extracted from *Tephrosia* seeds with sulphuric ether and from the ether free residue rotenone and resins are thrown off as precipitate by repeated washings with cold petroleum ether. These are then worked up in the usual manner. It appears that rotenone is concentrated in the root-bark and seeds and is practically absent in the stem or debarked root which explains our failure to isolate it on previous occasions.

(Ann. Rep., 1934-35). Systematic investigation of *Tephrosia*, *Milletia* and *Derris* sp. found wild in our forests is being planned. The richest samples, hitherto examined, of wild *Derris* or *Milletia* contained only about 2.5 per cent. of rotenone and 5 per cent. of total ether solubles. Judging from the prevailing standards for commercial *Derris*, that is 5 per cent. of rotenone and 16 per cent. or more of ether solubles, Indian species would appear to be very poor. These are of lower quality, no doubt, but even as such they have a place of their own. The low rotenone and resin content does not really take away much of its merits as an insecticide because the root powder has, after all, to be diluted with a considerable quantity of an inert substance like clay, in dusting preparations, in which 0.75 per cent. rotenone is considered sufficient. In *derris* dust preparations with a low grade *Derris*, the amount of inert diluent will be lower and consequently the concentration of the active *Derris* root particles will be higher. In this respect low rotenone content of the *derris* root turns out to be a matter of distinct advantage.

1-B. Oils and Fats

The investigation on the indigenous sources of lauric acid, as reported previously, has now been extended to *Actinodaphne angustifolia* and *Litsaea citrata*, and both of these fats are described below:—

(i) *Actinodaphne angustifolia*, Nees Syn., *Litsaea angustifolia*, Kurz, is an evergreen tree found in Assam, the Khasia Hills, Sylhet and Chittagong. Its berries yield 67 per cent. of kernels which contain 55 per cent. of a crystalline fat of the following constants:—

Melting point	. . . . .	42°-45° C.
Optical rotation $(\alpha)_D^{25}$	. . . . .	-2.1°
Specific gravity @ 35° C.	. . . . .	0.922
Refractive index @ 40° C.	. . . . .	1.4453
Iodine value (Hanus)	. . . . .	13.6
Saponification value	. . . . .	266.6
Acid value	. . . . .	7.9

The fat contains approximately 90 per cent. of trilaurin.

(ii) *Litsaea citrata*, Bl, is a very aromatic deciduous tree found in the Eastern Himalayas and the Khasi Hills. Its berries (sample from the Upper Tendu range, Bengal) yield 4.3 per cent. of an essential oil having a strong characteristic odour of lemon oil. This oil appears to be the same as that examined by Gardies (La Parfumerie Moderne, 1923. 107). The seeds yield 40 per cent.

of kernels which contain 54 per cent. of a crystalline fat of the following characteristics:—

Melting point	10°-12° C
Optical rotation (α) _D ^{25°}	-0.9°
Specific gravity @ 35° C.	0.911
Refractive index @ 40° C.	1.4401
Iodine value (Hanus)	5.9
Saponification value	269.5
Acid value	0.55

The fat contains approximately 95 per cent. of trilaurin.

(iii) *Bauhinia variegata*, Linn.—The oil from the seeds of an allied species *B. esculenta* is reported to be non-drying, edible and medicinal. The investigation of the oil from *B. variegata* was taken up hoping that this might also be of the nature of the above oil. *B. variegata* is a large deciduous tree found commonly in the Dun and Saharanpur Siwaliks. The kernels yield 16 per cent. of a pale yellow oil of the following physical and chemical constants:—

Specific gravity @ 30° C.	0.9206
Refractive index @ 30° C.	1.4603
Iodine value (Hanus)	91.3
Saponification value	211.4
Acid value	2.8
Unsaponifiable matter	11.7%

Mixed acids.

Iodine value (Hanus)	52.7
Mean molecular weight	294.0
Saturated acids	32.3%
Unsaturated acids	67.7%

Further work on the isolation and identification of the constituent acids is in progress.

(iv) *Solanum indicum*, Linn.—This is a much branched undershrub found commonly on waste lands in Dehra Dun and Saharanpur Districts. The berries yield 65 per cent. of seeds containing 10 per cent. of a yellow semi-drying, medicinal oil possessing the following constants:—

Optical rotation (α) _D ^{25°}	+0.5
Specific gravity @ 15.5° C.	0.9156
Refractive index @ 15.5° C.	1.4671
Iodine value (Hanus)	121.5
Saponification value	177.6
Acid value	17.8

On standing the oil deposits a small amount of a white crystalline non-nitrogenous solid which when crystallised from alcohol melts at 242°-243° C. Further work on this substance and the constituent acids of the oil is in progress.

(v) *Ximenia americana*, Linn.—It was reported last year that the oil contained an unsaturated acid which was named ximenic acid. It was also reported that this acid is not described previously to be present in vegetable oils and fats. Its relationship to cerotic acid found in the mixed acids of the oil was established. Further work has shown that the unsaturation occurs in 20-21 carbon atom. Proof of this was obtained from its products on acetone-permanganate oxidation, which were shown to be caproic acid and a twenty carbon atom dicarboxylic acid. The fact that this dicarboxylic acid is not identical with the normal 20 carbon atom dicarboxylic acid which had been prepared synthetically by previous workers led to a more careful examination of the original cerotic acid and it was found that this inactive acid could be resolved into its optically active components. This indicated that the cerotic acid must be a racemic mixture of "branched chain" acids and not a normal acid. The above inference, it might be mentioned, is supported by the fact that the melting point (83°-84° C.) of the cerotic acid from the oil is appreciably lower than what has been reported (88°-89° C.) for the synthetic normal acid and also by the statement [Jamieson, "Vegetable Fats and Oils" (1932) 293] that only the "branched chain" acid appears to occur in nature. The work on the constitution of cerotic acid also indicates that ximenic acid with which it is related is not a normal chain acid but a branched chain one, with an optically active carbon in the molecule. Details of the work on ximenic acid is interesting and will be described elsewhere.

2. Forest Soils.

On recommendations of the Silvicultural Conference, a soil chemist (Dr. R. S. Gupta) has been appointed. Since his appointment Dr. Gupta has been touring in sal (*Shorea robusta*) areas in Dehra Dun division and familiarising himself with the forest soils in general, and sal soils in particular. He has also been studying the changes brought about in soils when they pass from agriculture to forest conditions. An interim report on this investigation will be presented next year.

A large number of soils received from various forest officers were also examined during the year.

3. *Miscellaneous Enquiries.*

A large number of analyses were undertaken on behalf of forest officers, officers of the Institute and other departments of the Government and of these mention may be made of the following:—*Artemisia*; *Ephedras*; *Derris*; *Aquilaria agallocha*, *Prunus* sp., etc.

CHAPTER VII.—TIMBER DEVELOPMENT BRANCH.

During the year the Timber Development Section was placed in charge of a separate officer and made into a separate Branch of the Institute:—

The Timber Development Officer undertook the writing of short popular propaganda booklets on the following subjects:—

Treated wood for earthquake-resistant structures.

Special factors affecting timber design.

How to build wooden earthquake and storm-proof houses.

Treated timber bridges for Indian highways and railways.

Wood *versus* steel for framed buildings.

How to build fire-resistant timber structures.

Fire-proofing of wood.

Treated wood for roof trusses.

Treated wood for floors.

Treated wood for walls and ceilings.

These booklets were printed and released during the year under review. Over 16,000 were distributed free to the general public, businessmen and Government departments in India and abroad. These booklets raised considerable interest amongst various communities.

He also drew up designs and specifications for wooden bridges, 50-70 ft. span, roof trusses; a portable prefabricated hut and a watch tower—the last named at the request of the Chief Conservator of Forests, United Provinces, for use as a look-out for fire watchers in the forests. As a further aid to the popularisation of the use of treated wood, models of various types of bridges and trusses have been prepared. These models will be available for demonstration purposes and exhibitions.

The ban on treated wooden poles for carrying electric transmission lines having been lifted, large numbers of these poles have in the past few years gone into use for these purposes. In Northern India, one of the most suitable species for these purposes is chir (*Pinus longifolia*), considerable supplies of which are available in the Kumaon Hills. The Forest Department is, however, experiencing great difficulty in extracting these poles of the length required—40 ft.—owing to the sharp bends on these hill roads. To overcome this difficulty, attempts are being made by the Timber Development

Branch to evolve an efficient and at the same time sufficiently inexpensive type of joint, so that the poles can be extracted in lengths not exceeding 20 ft. A number of different types of joint have been tried out but while efficient enough, the cost is prohibitive and the appearance unsightly. Further experiments are being carried out to overcome these two defects.

Other species likely to be suitable for carrying electric transmission lines are being secured and will be given similar treatment and tested in the same way in the coming year.

The Timber Development Officer undertook an extensive tour, which included the more important industrial centres of Bombay, Madras, Calcutta and Delhi, and interviewed a large number of business men, engineers and others likely to be interested in the development of the uses of wood and particularly of treated wood.

APPENDIX I.
Publications of 1937-38.

Serial No	Title of Publication.	Author.	Date of Issue.
1	The formation of Heartwood and its amount in Deodar Timber.	M. A. Kakazal .	December 1937.
2	Entomological Investigation on the Spike Disease of Sandal (32) Lygaeidae (Hemipt.).	N. C. Chatterjee .	October 1937.
3	Cls Latr et Anobliides nouveaux des Indes . . .	M Fle . . .	October 1937.
4	Immature Stages of Indian Coleoptera (22) . .	J. C. M. Gardner .	October 1937.
5	New Crossotarsus (Platypodidae Col) . . .	C. T. C. Beeson .	December 1937.
6	Seed Weights, Plant per cents, etc, for forest plants in India.	J. N. Sen Gupta .	July 1937.
7	Illustrations of Indian Forest Plants, Part IV .	C. E. Parkinson .	July 1937.
8	Entomological Investigations on the Spike Disease of Sandal (31) Dermaptera & Orthoptera	L. Chopard & N. C. Chatterjee.	July 1937.
9	Second Interim Report on Work under Project VIII (Testing of Indian Timber for Veneer and Plywood).	W. Nagle . . .	July 1937.
10	Four New Indian Ichneumonidae . . .	R. A. Cushman .	December 1937.
11	The Silviculture & Management of the Bamboo (<i>Dendrocalamus strictus</i> , Nees)	P. N. Deogun. .	June 1937.
12	Indian Termitaria of the Section of Pentaptera .	C E. Parkinson .	July 1937.
13	Immature Stages of Indian Coleoptera (21) Cleridae	J. C. M. Gardner .	July 1937.
14	A Synecological Study of the Forests of Western Siam with special reference to their Geology.	H. T. Mooney .	March 1938.
15	Immature Stages of Indian Coleoptera (23) Carabidae.	J. C. M. Gardner .	March 1938.
16	New Indian Curculionidae (Col) . . .	Sir Guy A. K. Marshall.	(May 1938.)
17	Immature Stages of Indian Lepidoptera . . .	J. C. M. Gardner .	(July 1938.)
18	A Guide to the Insects of <i>Dalbergia sissoo</i> for Forest Officers.	....	(May 1938.)
19	Asen—A Wood Preservative . . . . .	....	(July 1938.)
20	A Note on Protecting Indian Structural Timbers against fire, termites & fungi (Holt) (<i>Reprint</i>).	S. Kameyam . .	(August 1938.)
OTHER PUBLICATIONS.			
21	Annual Return of Statistics relating to Forest Administration in British India, 1935-36.	....	December 1937.
22	Forests in relation to Climate, Water Conservation and Erosion.*	....	June 1937.
23	The Forest Research Institute & College, Central Library, Classified Catalogue, 1934.	....	(May 1938.)
24	Mercer's Tables (<i>Reprint</i>)	L. Mercer & Nand Mal.	January 1938.
25	Progress Report on Forest Research work in India, Part II.—Provincial Reports, 1935-36.	....	May 1937.
26	Progress Report of Forest Research in India, Part I.—Forest Research Institute, 1936-37.	....	December 1937.

* (Extracts from the Proceedings of the British Empire Forestry Conference, South Africa, 1935, reprinted.)

Publications of 1937-38—contd.

Serial No	Title of Publication	Author	Date of Issue
27	Progress Report of Forest Research in India, Part II—Provincial Reports, 1936-37.	....	March 1938
28	Classified List of Officers of the Indian and Provincial Forest Services and of the Indian Forest Engineering Service in India on 1st July 1937.	. .	March 1938
29	Annual Return of Statistics relating to Forest Administration in British India, 1936-37.	...	(November 1937)
30	Progress Report of the Forest College, Dehra Dun, 1936-37.		November 1937.

Contributions to Scientific Periodicals.

Silviculture.

- Champion, H. G. . . . Some Notes on the Kumpup method of Sal Regeneration (*Indian Forester*, Vol LXIII, p. 134).
- Hall, W. T. . . . Cultivation of Exotics in Kulu (*Indian Forester*, Vol LXIII, p. 512).
- Sen Gupta, J. N. . . . Forests of Upper Assam, Parts I and II (*Indian Forester*, Vol. LXIII, p. 731, and Vol. LXIV, p. 15).
- Sen Gupta, J. N. . . . Stand Improvement (*Indian Forester*, Vol. LXIII, p. 236).
- Trevel, Sir Gerald . . . Propagation of Selected Type of Forest Trees (*Indian Forester*, Vol. LXIII, p. 575).

Entomology.

- Gaudner, J. O. M. . . . Biological Control of Forest Insects (*Indian Forester*, Vol LXIII, p. 769)

Botany.

- Rairade, M. B. & Verma, B. S. . . . Indian plants reputed as fish poisons (*Indian Forester*, Vol LXIV, p. 198).

Utilization.

- Trotter, H. . . . Brush Treatments with Wood Preservatives (*Indian Forester*, Vol. LXIV, p. 112).
- Trotter, H. . . . Note on the Comparative Strengths of Sapwood and Heartwood (*Indian Forester*, Vol. LXIII, p. 593).
- Trotter, H. . . . Open Tank Treatment with Ascu (*Indian Forester*, Vol. LXIII, p. 672).
- Kamesam, S. . . . Standardisation of treated wood pole sizes for overhead electrical transmission supports (*Indian Forester*, Vol. LXIV, p. 43).
- Kamesam, S. . . . Role of treated timber in Indian structural economy (*Indian Forester*, Vol LXIII, p. 311).
- Kapur, S. N. . . . Drying Wood by ultra-short waves (*Indian Forester*, Vol LXIII, p. 248).

Chemistry.

- Krishna, S., & Puntambekar, S. V. . . . The oil from the seeds of *Ximenes americana*, Linn. A New Unsaturated Fatty Acid, Ximenic Acid. [*Jl. Ind. Chem Soc.* 15 (1937), p. 263-74.]
- Krishna, S., & Ghose, T. P. . . . Occurrence of Rotenone in *Milletia pachycarpa* (*Current Science*, August 1937, p. 57.)
- Krishna, S., & Ghose, T. P. . . . *Indian Tephrosia* sp as a source of Rotenone (*Current Science*, March 1938, p. 454.)

APPENDIX II.

*Publications of the Forest Research Institute, Dehra Dun,
available for Sale.*

SILVICULTURE SERIES.

BULLETINS (Old Series).

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*9. Tables showing the Progress in Working Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st Decembar, 1908, by the same author	0 10 0
*16. Note on the Best Season for Coppice Fellings of Teak (<i>Tectona grandis</i>), by R. S. Hole	0 4 0

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2. Memorandum on Teak Plantations in Burma, by F. A. Leete	0 10 0
*8. Note on some Germination Tests with Sal Seed (<i>Shorea robusta</i>), by R. S. Troup	0 2 0
*22. Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0 5 0
*30. The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
*33. Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
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*45. Note on the Miscellaneous Forests of the Kumaon Bhabar, by E. A. Smythies	1 0 0
*46. Rate of Growth of Bengal Sal (<i>Shorea robusta</i>), I Quality, by S. H. Howard	1 0 0
*47. Volume Tables and Form Factors for Sal (<i>Shorea robusta</i>), by the same author	0 6 0
*58. General Volume Tables for Chir (<i>Pinus longifolia</i>), by S. H. Howard	0 8 0
*62. Preliminary Yield Table for <i>Dalbergia sissoo</i> , by S. H. Howard	0 2 0
*65. Tables for bark deductions from logs, by S. H. Howard	0 3 0
*67. Chir (<i>Pinus longifolia</i>) Seed Supply, by S. H. Howard	0 3 0
*78. The Problem of the Pure Teak Plantation, by H. G. Champion	0 12 0
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†Silviculture of Indian Trees, by R. S. Troup, 3 Vols., for forest officers	40 0 0
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APPENDIX III.

Statement showing Officers-in-charge of Branches and Sections during the year 1937-38.

Branch	Officer-in-Charge.	Section	Officer-in-Charge.	From	To
Silviculture	Mr. M. V. Laurie, Silviculturist	..	..	1-4-1937	31-3-1938
		Experimental	Mr. J. N. Sen Gupta	1-4-1937	31-3-1938
		Statistical	Mr. M. A. Kakral	1-4-1937	17-4-1937
Botany	Mr. C. E. Parkinson, Botanist Forest	..	..	18-4-1937	31-3-1938
		..	..	1-4-1937	16-10-1937
		..	..	17-10-1937	31-3-1938
Utilisation	Mr. H. Trotter, Utilisation Officer	Mycology	Dr. K. D. Bagchee	1-14-1937	31-3-1938
		..	..	1-4-1937	31-3-1938
		Minor Forest Products	Mr. H. Trotter	1-4-1937	31-3-1938
		Timber Testing	Mr. V. D. Limaye	1-4-1937	31-3-1938
		Wood Preservation	Mr. H. Trotter	1-4-1937	31-3-1938
		Seasoning	Dr. S. N. Kapur	1-4-1937	31-3-1938
		Paper Pulp	Mr. M. P. Bhargava	1-4-1937	31-3-1938
		Wood Technology	Mr. K. A. Chowdhury	1-4-1937	31-3-1938
Entomology	(Mr. J. C. M. Gardner.)	..	..	1-4-1937	28-11-1937
		..	..	24-11-1937	31-3-1938
		..	..	7-10-1937	31-3-1938
Bio Chemical	Dr. S. Krishna, Bio Chemist	Systematic Entomology	Mr. J. C. M. Gardner	1-4-1937	31-3-1938
		..	..	1-4-1937	31-3-1938
Timber Development Branch	Mr. S. Kamezawa, Timber Development Officer	..	..	1-4-1937	31-3-1938
		..	..	14-5-1937	31-3-1938
		..	..	14-5-1937	31-3-1938
		..	..	14-5-1937	31-3-1938
	(Mr. L. R. Sahrawat.)	..	..	14-5-1937	31-3-1938
		..	..	14-5-1937	31-3-1938
	(Mr. S. Kamezawa)	..	..	14-5-1937	31-3-1938
		..	..	14-5-1937	31-3-1938
	(Mr. L. R. Sahrawat.)	..	..	14-5-1937	31-3-1938
		..	..	14-5-1937	31-3-1938

APPENDIX IV.

ANNUAL FORM No. 21.

FOREST RESEARCH INSTITUTE.

Summary of Revenue and Expenditure during 1937-38.

Budget Heads	Direction	Silvicultural Branch	Botany Branch	Entomology Branch	Physiology Branch	Chemistry Branch	Timber Development Branch	TOTAL.
1	2	3	4	5	6	7	8	9
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
REVENUE.								
V.—Miscellaneous—								
(a) Fines and forfeitures.	8	..	..	..	..	..	..	8
(b) Other sources .	40,440	77	220	22	8,716	288	..	49,703
(c) Leave contributions of officers on foreign service.	..	..	..	..	..	..	..	..
(e) Sale of timber and furniture from seasoning and Wood Workshop depot.	..	..	..	..	2,634	..	..	2,634
Total Revenue .	40,448	77	220	22	11,249	288	..	52,310
EXPENDITURE.								
C.—Conservancy, Maintenance and Regeneration—								
C. 1.—Purchase of stores, tools and plant	340	879	500	68	1,433	90	107	3,400
C. 2.—Communications and buildings, repairs, Maintenance.	..	..	..	..	..	..	..	..
C. 3.—Miscellaneous—								
(1) Temporary Establishment on daily labour.	456	1,054	4,301	3,282	3,705	..	140	12,838
(2) Purchase of Timber for seasoning and preserving (including freight and cartage charges).	..	..	..	..	3,880	..	..	3,880
(3) Purchasing of coal, raw materials, chemicals and apparatus.	..	..	..	574	12,478	2,078	..	15,130
(4) Other Charges .	303	3,450	2,417	810	20,820	307	18	28,225
Total C.—Conservancy, Maintenance and Regeneration.	1,120	5,383	7,228	4,734	41,103	2,475	225	52,058

Summary of Revenue and Expenditure during 1937-38—contd.

Budget Heads	Direction.	Agricultural Branch	Botany Branch	Zoology Branch	Utilisation Branch	Chemistry Branch	Timber Development Branch	TOTAL
1	2	3	4	5	6	7	8	9
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
B—Establishment—								
I—Pay of Officers—								
(a) Superior officers	20,000	12,000	0,007	27,880	20,100	.	.	88,333
—Non-Voted								
(b) Superior officers	300	14,110	28,968	14,146	83,058	26,629	9,800	1,77,380
—Voted.								
II—Pay of Establishment	1,703	22,861	0,411	23,876	97,487	8,555	1,848	2,00,743
III—Allowances—								
(b) House rent and other allowances	535	..	.	..	..	..	..	535
—Voted								
Travelling allowances—								
(d) Superior Officers—Non Voted	202	2,000	1,702	1,802	1,461	.	.	7,830
Voted—								
(c) Subordinate staff of forest and depot establishment	1,600	2,600	2,741	2,607	4,130	743	1,536	16,163
(f) Office establishments								
IV—Contingencies—								
(a) Stationery	102	3	26	6	8	..	..	145
(b) Carriage of records and prints	202	621	670	171	360	..	45	2,682
(c) Rents, rates and taxes.	0,601	105	221	4	170	..	..	7,101
(d) Pay of nonials	1,761	351	355	251	767	40	990	4,521
(e) Official postage	12,540	186	688	1,543	4,259	635	2,736	23,670*
(f) Sundries	473	85	87	84	311	31	17	1,088
(g) Clothing and uniforms								
(h) Telephones	807	112	312	351	1,027	140	138	3,147
V—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-Voted)	..	600	231	1,200	.	.	..	2,034
Total B—Establishments	86,010	57,876	52,080	73,410	2,13,248	34,770	17,170	5,35,862*
GRAND TOTAL OF ALL EXPENDITURE UNDER 10—FORESTS.	87,130	63,263	60,310	76,163	2,55,550	37,344	17,490	5,90,040*
Major Head B-A.—Share of Capital charges financed from ordinary revenue	..	..	..	..	..	.	..	..
Burplus or Deficit	-10,080	-1,110	-70,090	7,131	-2,41,301	-37,070	-17,400	-5,46,730*

* Details for the distribution of Rs. 70,000 included in these figures on account of publications through High Commissioner are being obtained from the Accountant General, Central Revenue, New Delhi.

NOTE—The figures given in the statement have been prepared in the President's Office and are based on the summary of Revenue and Expenditure for March 1938 received from the Accountant-General, Central Revenue. They do not include certain adjustments made in March final accounts by the Accountant-General, Central Revenue, on account of salary, exchange accounts with other Governments, and Expenditure incurred through High Commissioner on miscellaneous items.

L. MASON,

President,

Forest Research Institute and College

